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13. ABSTRACT (Maximum 200 Words) The Committee on Military Nutrition Research (CMNR) was established in 1982 under the auspices of the Institute of Medicine's Food and Nutrition Board. Its purpose is to provide reviews and recommendations to the Commander, U.S. Army Medical Research and Materiel Command, on research projects, programs, and products as they relate to the nutrition and performance of military personnel. During this reporting period, the CMNR met once to develop conclusions and recommendations for the upcoming report on <i>Caffeine for Sustaining Mental Task Performance: Formulations for Military Operations</i> . A Subcommittee of CMNR on Military Weight Management Programs was appointed. This Subcommittee held a 2-day, information-gathering workshop in conjunction with their first meeting. The purpose of the workshop was to review the latest research on physiological, psychological and environmental factors affecting weight gain/loss; and to review current weight loss programs for all branches of the Services. The Subcommittee met twice subsequent to the workshop to review military data on the prevalence of overweight among active-duty personnel, review the scientific literature and discuss potential conclusions and recommendations. Completion of both reports is expected by Fall of 2000.							
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FOREWORD

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May I Poos 1-20-00

PI - Signature Date

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Committee on Military Nutrition Research

Award Number DAMD17-99-1-9478

Annual Report for Period June 1, 1999 to May 31, 2000

INTRODUCTION

The purpose of this project is to continue the activities of the Institute of Medicine's Food and Nutrition Board standing Committee on Military Nutrition Research (CMNR). The purpose of the CMNR is to provide review and recommendations to the Commander, U.S. Army Medical Research and Materiel Command (USAMRMC), on research projects, programs, and products as they relate to the nutrition and performance of military personnel. This multidisciplinary standing committee is made up of experts in nutrition, food science, pharmacology, physiology, and behavior, and with knowledge of military procedures. The committee meets at least once per year and oversees the activity of subcommittees that have the necessary in-depth expertise to address each specific task requested by the military.

BODY

In June 1999, the CMNR report *The Role of Protein and Amino Acids in Sustaining and Enhancing Performance* was publicly released. Copies were delivered to the sponsor as required. The final report for the previous contract, *Committee on Military Nutrition Research: Activity Report 1994 - 1999* was also prepared and submitted. As requested by USAMRMC, a subcommittee of experts in weight loss, and weight maintenance was appointed by the National Academies. Membership Rosters for the Committee on Military Nutrition Research and its subcommittee on Military Weight Management Programs are in Appendix A.

A 2-day workshop entitled *Military Weight Management Programs: State of the Art and Future Initiatives* was held in conjunction with the first meeting of the Subcommittee on Military Weight Management on October 25-27, 1999 in Washington, D.C. The agenda, list of speakers and abstracts from the workshop are in Appendix B. During the closed session following the workshop, the Subcommittee reviewed the work statement and information provided by the workshop speakers, identified data to be obtained from the military, developed a report outline, and members' writing assignments.

The Military Weight Management subcommittee held a writing meeting on January 17-18, 2000 in Washington, D.C. The primary purpose of this meeting was to discuss preliminary data received from several of the Service Branches and identify additional data or additional analyses of the same data that would be needed to complete the report. Initial writing assignments were reviewed and additional information needs were identified. The subcommittee began discussion of potential conclusions and recommendations.

The CMNR met in Washington, D.C. on April 10-11, 2000. This was primarily a writing meeting and discussion of the final conclusions and recommendations to be made for the report *Caffeine for Sustainment of Mental Task Performance: Formulations for Military Operations*. This report is scheduled to go to external review in August of 2000.

The Subcommittee on Military Weight Management held a second writing meeting in Washington D.C. on May 15-16, 2000. Substantial additional material was added to the report at this meeting and responses to the Army's specific questions were addressed. The subcommittee has requested that the Grant Program Officer assist in identifying individual military bases for site visits by several subcommittee members to review on-base food service, and physical fitness facilities.

KEY RESEARCH ACCOMPLISHMENTS

Extensive reviews of the literature have been completed for the two current projects.

1. A thorough search of published scientific literature, both military and civilian, has been accomplished for the impact of caffeine on physical and mental performance, and all potential health concerns related to caffeine use.
2. A thorough review of the scientific literature has also been completed on factors known to affect body weight, such as genetics, gender, age, activity, diet and nutrition, and environmental factors. Critical components of effective weight management have also been reviewed.

REPORTABLE OUTCOMES and CONCLUSIONS

None to date

APPENDIX A

COMMITTEE ON MILITARY NUTRITION RESEARCH

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Karah Nazor
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APPENDIX B

Workshop Agenda

Military Weight Management Programs: State of the Art and Future Initiatives

Subcommittee on Military Weight Management
Committee on Military Nutrition Research
Food and Nutrition Board
Institute of Medicine, National Academy of Sciences

October 25-26, 1999
2001 Wisconsin Avenue, N.W., Washington, D.C.

Monday October 25, 1999

8:30 am Registration and check-in

9:00 Welcome on Behalf of the Food and Nutrition Board
Dr. Allison A. Yates, Director, Food and Nutrition Board

9:05 Welcome on Behalf of the Subcommittee on Military Weight Management
Dr. Richard Atkinson, Chair, Subcommittee;

9:15 Opening Comments on Behalf of the Military
LTC Karl E. Friedl, U.S. Army Medical Research and Materiel Command, Fort Detrick, Frederick, MD

9:30 Important Historical Military Data: Obesity and Mortality
Dr. William Page, Senior Staff Officer, Medical Follow-up Agency

Part I: Weight Management in the Military Today (Moderator: Richard Atkinson, M.D.)

9:45 am Panel: Current Military Policies and Approaches to Body Weight Management

*LCDR Sue Hite, Health and Physical Fitness Branch, USN
LTC Francine LeDoux, Health Promotion Policy Officer, USA
LTC Leon Pappa, Training Program Branch, USMC
COL Esther Myers/LTC Regina Watson, Chief, Health Promotion, USAF*

Discussion

11:00 BREAK

11:15 Challenges to Military Weight Standards and Maladaptive Practices of Service Members to Meet These Weight Standards
MAJ Stephen Bowles, M.D., U.S. Army Soldier Support Institute, Ft. Jackson, SC

12:30 LUNCH – (on your own – Refectory)

Discussion

12:00 pm LUNCH BREAK

1:00 **Physiology – Physical Activity (Moderator: Barbara Hansen, Ph.D.)**

Effects of Exercise, Diet, and Weight Loss on Lipid Metabolism

Dr. Marcia Stefanick, Stanford University

Reproductive Health Issues in Fitness and Weight Control Programs

Dr. Anne Loucks, Ohio University

2:00 **Obesity: An Infectious Disease?**

Dr. Nikhil Dhurandhar, Wayne State University

2:25 Discussion

Part IV: Factors Affecting Long Term Maintenance of Weight Loss – Weight Regain

(Moderator: Arthur Frank, M.D.)

2:45 *Dr. George Blackburn, Harvard Medical School*

Dr. John Jakicic, Miriam Hospital and Brown University

Discussion

3:45 BREAK

Part V: Effective Strategies for the Military Setting (Moderator: Gail Butterfield, Ph.D.)

4:00 Panel Discussion

Military Speakers: *CAPT Trisha Voracheck (USAF)*

LT Deborah White (USN)

Dr. H. Glenn Ramos (USA)

LT Kerryn Davidson (USA)

Civilian Speakers: *Dr. Frank Greenway*

Dr. John Jakicic

Dr. Patrick O'Neil

5:00 Summary of the Workshop

Dr. Richard Atkinson, Subcommittee Chair

Dr. John Vanderveen, Vice-Chair

5:30 pm ADJOURN

WORKSHOP ABSTRACTS

1. AR 600-9, THE ARMY WEIGHT CONTROL PROGRAM

LTC Francince M. LeDoux, Health Promotion Policy Officer

PURPOSE: to establish policy and procedure for the implementation of the Army Weight Control Program.

OBJECTIVE:

The primary objective of the Army Weight Control Program (AWCP) is to ensure that all personnel are able to meet the physical demands of their duties under combat conditions; present a trim military appearance at all times. Assist in establishing and maintaining discipline, operational readiness, optimal physical readiness, effectiveness of Army personnel through proper weight control; Establish appropriate body fat standards; provide procedures for which personnel are counseled to assist meeting the standards prescribed in the regulation.

HISTORICAL PERSPECTIVE:

Pre 1981: Height/weight tables and physician assessment used to determine body fat standards.
1981: DOD Directive 1308.1, Physical Fitness and Weight Control Program stated various tests were okay.
1983-6: Army used "pinch test."
1986: AR 600-9, The Army Weight Control Program published.
1987: DOD Directive 1308.1 "Tape" test only. Skinfold measurement deleted.
1994: Interim Change 101, All soldiers Handbook/ Issue 15
1995: DOD Directive 1308.1 Body fat standards changed, established standards for pregnant soldiers.

RATIONALE:

The AWCP is based on body composition (body fat vs. total body mass); physical fitness is key to body composition; fit soldiers are an easy "go" when taping; excessive body fat detracts from soldierly appearance. Overweight and fit soldiers are better able to carry their load. They have less body fat and more muscle mass. In contrast, overfat soldiers have more underdeveloped muscles; perform physical tasks less well; are at risk of developing injury; have lower Army Physical Fitness Test scores.

KEY REQUIREMENTS:

Soldiers are weighed every six months; taped for percent body fat if they are overweight. The circumference method ("tape test") is used. The measurement sites are males: abdomen, neck with a range of 20-26% (maximum), females: neck, forearm, wrist and hip with a range of 20-36% (maximum). If a soldier is overfat he/she is enrolled in the AWCP.

KEY REQUIREMENTS:

AWCP enrollment. Soldiers are flagged; Nutritional Counseling (as standard requirement); Monitored Monthly (weighed); Removed by body fat standards only. Not by meeting the HT/WT table standards; can be discharged per AR 635-200, Chapter 18, Personnel Separations, if the soldier fails to make satisfactory progress in two consecutive months. The standard is 3-8 pounds per month.

PREGNANT and POST PARTNUKM SOLDIERS:

Once a female soldier is diagnosed as pregnant, she is exempt from standards of AR 600-9. Exempt during pregnancy and six months post partum. The soldier will remain in the program if she was enrolled previously. After 6 months postpartum, she will continue on the AWCP with physician clearance. Postpartum soldiers may request to be weighed anytime before six months. This standard implements DOD Directive 1308.1, July 20, 1995.

MEDICAL LIMITATIONS:

Pregnancy, hospitalization, and prolonged treatment, positive profiles Mandatory Medical Review Boards (MMRB). This regulation is presently being updated and revised to be submitted to the field for staffing.

2. CHALLENGES TO MILITARY WEIGHT STANDARDS AND MALADAPTIVE PRACTICES OF SERVICE MEMBERS TO MEET THESE WEIGHT STANDARDS

MAJ Stephen V. Bowles, Ph.D., United States Army Soldier Support Institute, Director, USAREC Command Psychological Operations Fort Jackson, South Carolina

The opinions expressed in this article reflect the views of the author and do not reflect the opinion of the Department of the Army, Department of Defense or the U. S. Government.

At the time this abstract was written no information on service members who exceed weight standards or have been discharged from the service in 1999 could be obtained from the DOD or individual services. It has been reported that as many as 40% of the soldiers discharged from the Army was due to service members being overweight (James, Folen, Bowles, Kellar, & Supplee, 1997). The Military faces several challenges to include: over weight accessions into the military, lifestyle practices of overweight service members, and command awareness of lifestyle change programs.

Challenges to Military Weight Standards Challenges

With current recruitment shortfalls the number of overweight recruits (meeting accession standards but not the services standard for weight) may be increasing due to a smaller applicant pool. This can translate into a considerable number of overweight personnel entering yearly that meet accession standards but do not meet military standards at that time. This may place extra strain on a system to get personnel physically fit, while preparing new service members for the complexities of the Military. In addition, these places increased stress on young service members who are in many cases away from home for the first time in their first job.

With this in mind, educating recruiters on healthy lifestyle changes for new recruits may be beneficial. This may help us reduce the time we spend on new overweight service members and retain more personnel. Recruiters can be provided with lifestyle change training in recruiting school and provide recruits with approaches to healthy lifestyle change. Similarly, Military academies and ROTC programs can provide training to new officers throughout their school years. Students must be trained in maintaining healthy lifestyles in accordance with Military weight guidelines. These are important preventative measure in stressful academic environments, which may preclude students from engaging in maladaptive eating behaviors.

Eating on the run is sometimes dictated by our mission. When training new service members today we have attempted to offer adequate time to eat in our dining facilities. This is different from the past where older overweight service members have identified early dining experiences as eat as much as they can in as little time as possible. This set the pattern of their eating over the course of their military careers. When providing new personnel training and education to healthy lifestyle behaviors we must incorporate these changes into our training structures as best we can. As a tradition, service members have complained about the food provided to them in the mess hall or galley. However, great improvements have been made in the quality of foods. More effort needs to be initiated in educating cooks (James, Folen, Page, Noce, Brown, and Britton, 1999) to provide more variety in the low fat main dishes served for lunch and dinner. Furthermore there should be uniformity across dining facilities in the education of customers on calorie and fat gram amounts per food served.

Maladaptive Practices of Service Members

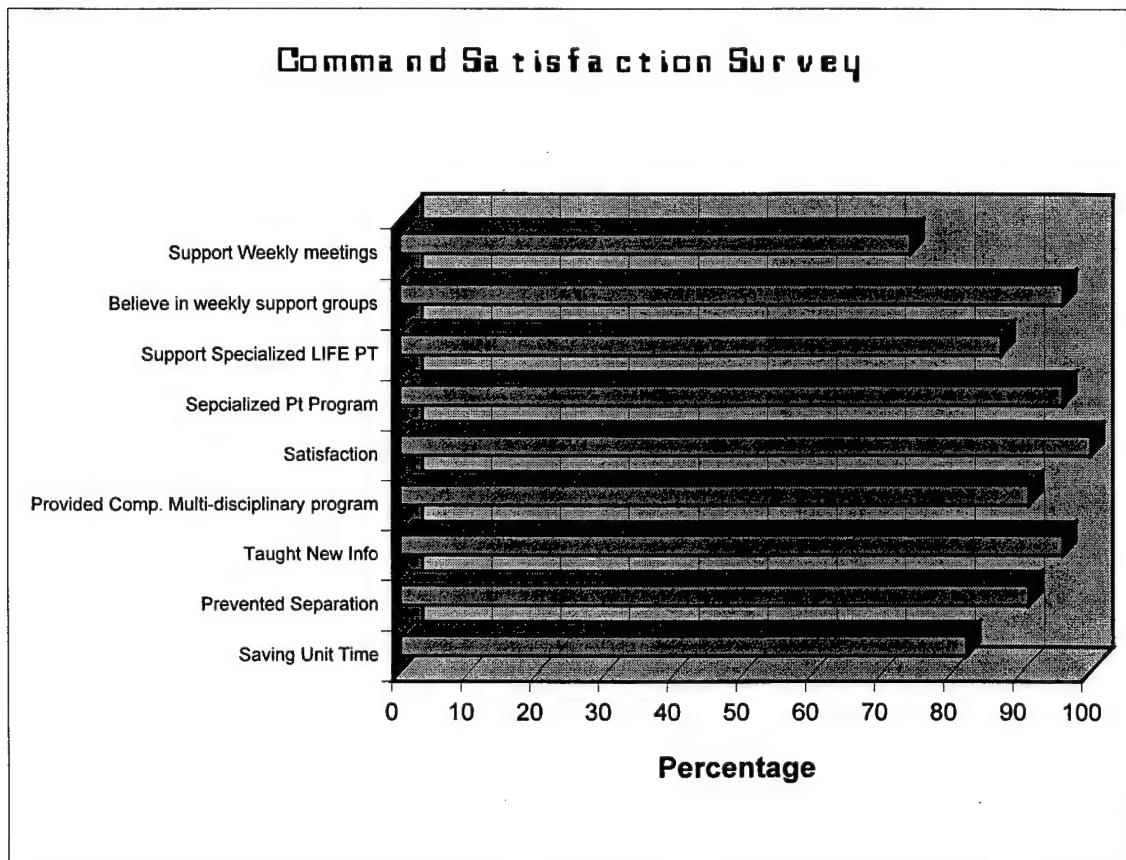
While there are differences in each of the services military weight /body fat standards, the goal of each service member twice a year, is to meet the weight standard and pass the physical fitness test. The family is well aware of the borderline or overweight service member's plight at these times of the year. There is often tension in the home emanating from the service members desire actions to stay off the weight program. This may involve physical fitness training 5 times or more a week. Additionally service member will attempt to loose weight by using over-the counter medication. They may go to the local health food store and purchase different herbal supplements. Or attend a local weight reduction clinic and get on prescription medication. They will sit in the Sauna, or they may obtain laxatives through the local drug store or their medical facility if they are on the hospital staff. If they are looking for the more popular diets they can choose from protein, blood, cabbage, grapefruit or what ever the most recent diet is. Of the 108 applicant records examined for the Eisenhower LIFE Program, 34% reported starving or fasting, 33% reported using laxatives or over-the counter medication and 4% reported purging at some time in their career.

Meeting Military Weight Standards: Lifestyle Change Programs

Across the services there is a need to become more familiar with various programs available in local areas and encourage the use of these programs. Units that have used local lifestyle change (weight) programs are able to save financial resources for their organizations and save units time if their armed service program is several hours or states away from where they are located.

As a group, the medical field must educate the Commanders in their area on services available to assist service members in weight reduction. Commanders, after seeing the results of their service members in lifestyle change programs, will be a steady referral source to programs. The Eisenhower LIFE Program (a week day treatment program and 1 year follow-up) disseminated a 11 question survey asking Commanders and supervisors for their feedback on the program. The results of 9 of the questions from the survey are found below. Ninety percent of the respondents were from the Army while the remainder of the respondents were from the Air Force, Navy and Marines.

The results of the survey indicate that of the 22 out of 24 Commanders/supervisors responding, all were



satisfied with the program. Most respondents agreed that the program saved their unit time (81%), prevented the service member from separation from the military (91%), taught the service member new information for weight management (96%), and provided a comprehensive multidisciplinary program for weight reduction (91%). In addition, 96% believed a specialized physical training program is helpful for weight reduction while 86% supported a specialized LIFE physical training program. While 95% believed weekly support groups are helpful, only 73% supported service members attending weekly support groups. Though some Commanders/supervisors prefer to operate their own physical training and follow-up support (perhaps due to unit esprit de corps or due to shortage of work personnel), these results suggest that overall Commanders support this lifestyle change program.

These findings suggest that Commands are open to the assistance from weight reduction programs to maintain readiness levels in their organizations. Similar education and training can be provided across services to assist service members in meeting their organizations weight standards. The training provided to service members and in support of service members can be provided through healthy lifestyle change programs.

3. THE SENSIBLE WEIGH LIFESTYLE CHANGE PROGRAM: AN AIR FORCE WEIGHT MANAGEMENT PROGRAM

Joanne M. Spahn, Lt Col, USAF, BSC, MS, RD

The health risks associated with overweight and obesity are well established^{1,2} and the incidence of overweight continues to rise.³ In the military, sustained overweight can end an otherwise successful career. An increased operations tempo, decreased physical activity and easy availability of high calorie dense foods may frustrate earnest weight management efforts. Until the 1990s, the typical Air Force treatment program for overweight entailed a single group class where military members were given instruction on a low calorie diet, typically 1200 - 1800 calories, information on behavior modification and counseled to exercise three to five times a week for 30 minutes. In the late 80s and early 90s, numerous published or home grown multi-session programs were established at a variety of sites. These programs for the most part emphasized increased physical activity, modest calorie restriction, and skill development in selecting and preparing healthy foods and behavior modification techniques. At most sites, these programs could accommodate few participants. There was fear among active duty personnel that weight loss would be too slow to meet weight loss requirements.

In the early 1990s, the National Institutes of Health held a Technology Assessment Conference on Methods for Voluntary Weight Loss and Control. In 1995, Weighing the Options. Criteria for Evaluating Weight-Management Programs was published.⁴ These materials were utilized to guide development of The Sensible Weigh Program initiated in 1997. Practical managerial constraints and Weight Management Program (WMP) guidelines factored into program development. Specifically, this included the need for military members to loss three to five pounds the first month identified as overweight to avoid disciplinary action and the need for Wing and Army Commander support of treatment incorporating increased use of duty time. Deployment of Sensible Weigh to a large number of bases with varying levels of manpower support has also shaped program implementation across the Air Force.

The Sensible Weigh is a lifestyle change program aimed at optimizing weight and fitness of military members and their families. It is a science-based protocol designed to prevent weight gain, facilitate weight loss and the maintenance of weight loss. It was developed to support the Air Force WMP and as an avenue for commanders and health care providers to intervene with concerned individuals early, before negative consequences occur. This multidisciplinary program offers participants a variety of strategies from which to choose to improve their nutrition, fitness and health. Program materials are available on the web at the following site: <http://afmam.satx.disa.mil>

Clients enrolling in The Sensible Weigh can either self-refer, be sent by their squadron, or be referred by a medical provider. The protocol begins with a thorough assessment of anthropometric, biochemical parameters, comorbidities, medications, family history, weight and dieting history, exercise habits, diet readiness and evaluation of the Physical Activity Readiness Questionnaire. Nursing personnel review the assessment form with clients and use standardized guidelines to refer clients to medical providers when the need arises. Assessment data is used to tailor the program to meet client needs, discuss the benefits of weight management in terms other than pounds lost and to facilitate measurement of program efficacy.

Program length varies from four to twelve weeks. The first four core classes are taken by all participants in The Sensible Weigh and provide a foundation of information and skills. The first class orients clients to the concept of lifestyle change, the diverse benefits of weight management, addresses relapse prevention, diet readiness and encourages increased physical activity. Clients are instructed on how to complete a food and exercise diary and are required to monitor their eating habits for the coming week. This is an important class for establishing rapport, venting anger and building a trusting relationship. This was a difficult class to implement because of the immediate penalties incurred if members did not loss the prescribed weight in the first 30 days. Members and supervisors were concerned that the member did not "get the diet".

During the second class each client receives a calorie and fat budget following Step I diet recommendations. Clients are offered a variety of strategies from which to choose to modify their diet. Strategies include calorie counting, fat gram counting, following food guide pyramid guidelines and following a calorie controlled meal plan. Pros and cons of each method are discussed and clients select the strategy they feel best meets their needs. The food and exercise diary is used to track progress. Instructors, called coaches, review food diaries at each visit and provide individualized coaching on strategies to improve the healthfulness of the client's diet and fitness regimen and provides encouragement. It takes a few weeks for many clients to get proficient on maintaining a food diary.

Class three is taught by an exercise physiologist who covers the basic components of a personal fitness program targeted at reducing body fat. American Academy of Sports Medicine fitness guidelines are used. A strong emphasis on fitness is crucial in this young, moderately overweight and healthy population.⁴ Members are encouraged to have a personalized fitness prescription designed for them by the exercise physiologist. The forth

class covers the basics of behavior modification and the concept of behavior chains. During the final core class, clients sign-up for their next four electives. Client goals and Diet Readiness Test results are utilized in deciding what electives might be most beneficial.

Electives are taught by a variety of people from diverse disciplines and may include skill development classes on dining out, supermarket tours and cooking demonstrations; stress management and classes covering relapse prevention, cognitive-behavioral therapy and a variety of fitness topics. Support groups are offered weekly and participants are encouraged to attend one elective or one support group per week. This modular approach facilitates tailoring the program to the diverse needs of a population and allows for more flexible use of limited manpower resources. Electives are typically scheduled two times per month.

Outcome statistics have been maintained on The Sensible Weigh. Between February 1997 and June 1998, 656 clients enrolled in The Sensible Weigh. Of this group, 24 percent were active duty, 38 percent were family members of active duty personnel, 8.9 percent were retirees and 28 percent were spouses of retired personnel. Thirty three percent were self-referrals and 49 percent were referred by the Family Practice Clinic. At three month follow-up, 163 (25 percent) returned and the average weight loss was 11.2 pounds. At six month follow-up, 50 (10%) of clients returned for follow-up with an average weight loss of 15.7 pounds. Between October 1998 and February 1999, 94 active duty personnel were enrolled in The Sensible Weigh. Fifty-two (55%) returned for 3-month follow-up (21 Air Force, 21 Army personnel) and an average of 11.5 pounds was lost.

The Sensible Weigh represents incremental improvement in weight management treatment in the Air Force. The program has been exported to many Air Force bases worldwide and a one-week training program has been developed to train Sensible Weigh coaches. Recent changes in Air Force Weight Management Program guidance have made implementation of the Sensible Weigh easier, particularly the requirement for a 90-day fitness and dietary program and the official implementation of a warning or cautionary zone prior to enrollment into the program. The withholding of promotions during this cautionary phase however, is still considered a significant program penalty. The new 90-day period, provided for a fitness and exercise program, allows members more time to address readiness to change issues. Few members referred due to the Weight and Body Fat Management Program come voluntarily and many would fall into Prochaska's pre-contemplation and contemplation stages of change.⁵ Most programs currently offered are tailored for clients in the preparation and action stage.

Posting Sensible Weigh materials on the Air Force Medical Applications Model web site has facilitated implementation of the program at multiple sites and allows for a certain degree of standardization of weight management treatment at numerous sites. Standardized treatment programs have many benefits including the potential to improve staff training, improve continuity of care in a highly mobile population, facilitate increased collaboration, testing of hypotheses which could lead to program improvement and allows for efficient program updates. Use of one standardized program however, is not sufficient to meet the needs of the entire population.

Availability of a variety of standardized programs using a variety of educational modalities would provide increased flexibility for service members particularly those frequently deployed or on field duty. Research which describes characteristics of personnel on the weight management program, barriers, enabling factors, stage of change information, current diet and fitness habits, typical lapse situations, strategies currently used for weight loss, sources of weight management information and preferred modes of education would be helpful in the development of programs tailored to the unique needs of military personnel and their families.

Community programs, which address both prevention and treatment of overweight in military communities, are essential. The Sensible Weigh provides treatment on the individual level, but community programs that address environmental support for health and fitness are crucial.

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4. THE AIR FORCE LEAN PROGRAM

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Prior to the July 1999 policy changes in the Air Force (AF) weight management program (WMP), most AF members identified as over body fat received only a 2-hour nutrition class, taught by a registered dietitian or nutrition certified diet or medical technician, before officially entering the WMP and being monitored for successful weight loss progress. Once placed in the WMP, members were required monthly to lose either 3 pounds if female or 5 pounds if male or percent body fat until the body fat standard was reached. If members did not make satisfactory progress, punitive action was taken, and after 4 failures, members were discharged from the AF. With only a 2-hour nutrition class to assist members in successfully attempting to reach their body fat percentage goal, WMP discharges, as well as members and commanders' frustrations, were high. Therefore, in response to commanders' requests to develop a more positively focused WMP, the Lifestyle, Exercise, Attitude and Nutrition (LEAN) weight loss program was developed and implemented at McConnell Air Force Base (AFB) in October 1995.

After reviewing the current research on weight loss programs, the LEAN program was developed by a multidisciplinary team that included a physician, registered dietitian, psychologist, mental health technician, fitness specialist and the base health promotion manager. The newly created LEAN program was a mandatory, multidisciplinary 4-week program for all active duty (AD) members identified for the WMP after 15 Oct 1995. The LEAN program met weekly for 2 ½ to 3 ½ hours, and during each session, nutrition, behavior change and exercise were taught by a registered dietitian, psychologist and exercise physiologist, respectively. Each member was required to attend all four sessions prior to officially being placed in the WMP. While in the LEAN program, members were not allowed to go on temporary duty or leave, except for emergency situations. Squadron commanders or first sergeants were notified of all missed appointments, and the member was automatically scheduled for the missed class in the next month's LEAN program. A new LEAN program started each month, and one week prior to the start of a new program, any remaining open slots were opened to AD volunteers, dependents and retirees. After completing the LEAN program, members were required to attend a monthly group follow-up session until they met their body fat standard.

The nutrition component of the LEAN program included guidelines on healthy weight loss, principles of the Food Guide Pyramid, food label reading, calorie and fat gram counting, self monitoring, dangers of fad dieting, low-fat cooking techniques and healthy dining out. The behavior change portion of the LEAN program consisted of assessing stage of readiness, stimulus control, breaking associations, generating social support, realistic goal settings stress management, and relapse prevention. Finally, the exercise component included recommendations and hands-on training regarding proper exercise warm-up and cool-down, stretching, aerobic conditioning and strength training. The monthly group follow-up sessions expanded on the already discussed LEAN program topics, and monthly rotated between each discipline.

Only 9 months after the initial implementation of LEAN program, the program experienced great success. There was a 50 percent decrease in the percent of AD population on the WMP and over a 60 percent decrease in the monthly failure rate in the WMP. The LEAN program was also cited as one of the top three best things about McConnell AFB at the Senior Enlisted Advisor's Enlisted Call. Without a doubt, the greatest strengths of the LEAN program were the multidisciplinary approach and the length of the program. It was the first AF program to provide members with increased education, skills and support in all the disciplines necessary for successful weight loss *prior* to official placement in the WMP. The success of the LEAN program was a key factor in the current AF policy of members receiving 3 months of weight loss counseling prior to starting the WW.

Although I strongly agree that the military individual WMP needs improvement, I would also highly encourage the committee to consider making recommendations for environmental approaches to improving the military's WMP. Broad policy changes in regards to nutrition and exercise can have a much greater impact on the military's population as a whole than even the best individual focused weight loss programs. For example, we know from current research that availability, taste and price are three of the greatest factors affecting food selection today (Colby, 1987, Glanz, 1998 French, 1999, National Restaurant Association and Gallop Organization, 1986 and National Restaurant Association, 1984). Therefore, example policies could be: all base eating establishments must have at least 30 percent of their menu as low-fat selections; or all low-fat foods in vending machines and cafeterias must cost 30 percent less than the high fat food choices; or all food service personnel receive at least 1 week of low-fat cooking training during their technical school; or for at least 1 week every quarter, the food service workers on base receive additional training on low-fat cooking from a certified executive chef and culinary trainer. I commend the committee for addressing the need for changes to the counseling portion of the WMP, and I challenge the committee to take the next step and recommend policy changes that modify the military's environment to decrease barriers and enable the population as a whole to become more fit and healthy.

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5. The Impact of a Shipboard Weight Control Program

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Background

Superimposed on obesity's risk factors for cardiovascular disease (CVD), Navy personnel who fail to meet Physical Readiness Test (PRT) and body weight standards are subject to potentially serious administrative sanctions, such as ineligibility for promotion or potential termination of their military careers. With impact beyond the well being of the individual service member, these administrative actions may signify the Navy's forfeiture of its investment in the development of personnel's unique knowledge, skills, and services. Although obesity has been projected to cost the Navy considerable dollars in inpatient bed days (9), to our knowledge, health care expenses due to this particular condition and its associated sequelae among Navy personnel have never been quantified. Yet this is only a portion of the total economic impact of obesity (3).

To assist its obese service members in attaining weight and fitness standards, the Navy implemented a multiple-tiered obesity treatment program. However, this remedial approach is not standardized and it typically fails to bring the majority of participants within weight standards (14). In addition, over 80% of program time is devoted to physical activity even though 63% of enrollees are obese (13) who need state-of-the-art, multi-faceted weight loss programs (8, 15).

Aims

This study assessed whether a multi-faceted approach to weight loss and physical readiness could be implemented onboard ship, evaluated factors at sea that could affect the program's implementation, and determined its relative effectiveness in helping obese service members meet weight and physical fitness standards. Uniquely, this study also documented the economic impact (cost-effectiveness and cost-savings) of the shipboard weight control program relative to the current Command Level program.

Methods, Intervention Component

Thirty-nine men (31 ± 6 yr. old, mean \pm sd) assigned to the USS ENTERPRISE (CVN 65) during a 6-month Mediterranean deployment who had failed their previous PRT due to excessive body weight (108 ± 11 kg overweight) were randomly assigned to: 1) an experimental treatment of weekly sessions on diet, behavior modification, psychosocial issues, plus the current command level program of exercise; or 2), a usual care control treatment comprised of the existing command level program of exercise alone.

The goal of the experimental treatment was to educate participants in effective, realistic, and acceptable ways to adopt lifestyle, lifetime behaviors conducive to healthy nutrition, long-term weight control, and physical activity. The format was small group lecture/discussion conducted by a Navy dietitian. Groups of 10-12 individuals met in hour-long, weekly sessions for 16 weeks of the 6-month deployment to fit within the constraints of deployment time, departure from and return-to-port activities, as well as data collection onboard. The diet followed NCEP Step I (Heart Healthy) guidelines for dietary composition, with portions controlled to decrease energy intake by 500 calories/day to promote weight loss of 0.5-1 kg/week. The dietitian used a standardized instructor manual, and each participant received a notebook of course material generated and used in numerous studies in the Geriatric Research Education and Clinical Center at the VA Maryland Health Care System, Baltimore (4, 5, 7, 10-12). Behavior modification consisted of teaching participants well-documented behavioral modification techniques, such as dealing with external stimuli associated with eating occasions, and managing holidays and special events, including shore liberty. Combining a greater knowledge of food choices with an understanding of behavioral techniques enabled participants to select foods from a wider variety of alternatives, fully consider the consequences of each one, and structure the environment for success. Self-monitoring was introduced as a new lifestyle behavior that is central to achieving the desired weight loss outcomes. Interpersonal processes were designed to build camaraderie and

group support as participants were guided to creatively problem solve and adopt a series of small, achievable steps that had a cumulative impact on body weight.

The exercise program for the experimental group was the mandated program already being conducted for Command Level remediation (i.e., "Navy usual care"), which consisted of one hour of exercise 4 days per week. Established exercises included cud-ups, push-ups, walking, jogging, and other aerobic exercises conducive to successful completion of the PRT. PRT in the Navy involves sit-reach, cud-ups, push-ups, and a 1.5 mile run. Although standards are age- and gender-based, the "average" 31 year old male participating in this study would need to touch his toes with legs out-stretched, perform 32 cud-ups and 23 push-ups, and run 1.5 miles in 15 minutes / 30 seconds to pass the PRT. Exercise was not experimentally controlled because the intent of the study was to evaluate the addition of a standardized dietary behavioral modification component to the Navy's existing program.

Like the experimental group, men in the "usual care" control group (i.e., existing Command Level remediation program) knew that weight loss was requisite to continue their Navy careers beyond an 18-month grace period. While these men were provided nutrition fact sheets and brochures if requested, they did not receive group or individual counseling. The control group received "usual care" by participating, as required, in the current command Level I program of exercise described above for the treatment group.

Results, Intervention Component

Prior to treatment there were no significant differences in body composition parameters (weight, BMI, %body fat, waist and hip girths, WHR) between men in the treatment and control groups. However, outcomes for the treatment group were significantly better than the controls, with 8.6 ± 5.0 vs. 5.0 ± 4.1 kg weight loss, 8 Vs 5% reduction in original body weight, and body fat loss of 7 Vs. 5%. Moreover, 10 men in the treatment group Vs. only 2 in the control group lost @10 kg of their initial body weight. Prior to treatment, most CVD risk factors reflected values that were within NCEP guidelines. The exception was HDL-C, which averaged 35 ± 8 mg/dl for the total group, and was low enough to place these men at increased CVID risk. With weight loss and exercise, triglycerides declined significantly greater in the treatment group than the controls (145 to 109 mg/dl Vs. 146 to 145 mg/dl, $p < .05$)

At baseline, despite random assignment, men in the treatment group reported significantly greater binge eating symptoms, less use of eating behaviors conducive to weight loss, and more difficulty controlling overeating at times of negative affect than men in the control group. At the end of the program, however, treated men had significant improvements in all of these elements, as well as a significant improvement in the difficulty they experienced controlling overeating in certain social circumstances. Beginning worse than the control group, men in the treatment group finished the study with similar or better eating behaviors than their counterparts. These outcomes hold even when controlling for significant differences pretreatment.

Problematic environmental factors were the limited variety of heart healthy foods in the galley, short meal breaks and long mess hall lines that led to eating snacks from vending machines, and frequent port calls. Although greater weight loss than would be expected of a Command Level remedial group diluted the treatment effect, the treated men still fared significantly better (6).

Methods and Results, Intervention Cost-Effectiveness

To examine the cost-effectiveness of the standardized shipboard weight control program (SBWC) Vs. the Navy's current exercise-only Physical Readiness (PRT) test remediation, costs were examined from the Navy (long-term) and Command (short-term) perspectives. The Navy's costs, both direct (i.e., intervention and personnel replacement) and indirect (i.e., participant's and obesity-related health care savings), formulated the cost-effectiveness analysis. The frequency and probability of medical events in the Navy active duty population, valued at Medicare cost rates, generated total inpatient and outpatient obesity-related expected per person health care costs to calculate cost-saving from the effects of the innovative shipboard weight control and the current Command-level interventions.

The SBWC was more expensive to deliver than the PRT-exercise only remediation. The per-person expense for the SBWC was \$1,269, which consisted of \$509 for the conduct of the intervention plus \$722 in the participants indirect costs. The Command-level, PRT exercise-only cost per-person was \$760, with \$38 for the intervention and the same \$722 of indirect costs. Additionally, \$65,561 is required to replace the average service member when dismissed for PRT non-compliance. However, these PRT-intervention and replacement costs apply only to personnel in PRT remediation or those who are discharged, so the probability of these events is accounted for in the final calculation of expected per person costs of: \$143 for the PRT exercise-only and \$195 for the SBWC remediations, at the Command level. The "effect" measure is the percent of weight loss, which is the most

meaningful clinical outcome achieved by the two interventions under scrutiny. The SBWC and PRT groups on average achieved weight reductions of 7.8% and 4.6%, respectively; indicating that the SBWC is more effective.

The simple or "average" cost-effectiveness ratios indicate that the SBWC is cheaper to deliver, considering the gains achieved, under either the Command or Navy perspective. Exercise-alone remediation annually costs the Command (per person) \$31 per percent weight loss achieved, while the SBWC costs \$25. In the Navy's perspective, PRT-exercise-only obtains a ratio of \$19 per percent weight-loss achieved while SBWC obtains a value of \$13. These ratios indicate the SBWC is "dominant" across perspectives with consistently lower average annual per person costs per effect unit achieved.

Because the SBWC is an enhancement of the PRT-exercise remediation, the cost effectiveness analysis (CEA) also can examine the preferred cost-effectiveness of program efficiency, the incremental cost- effectiveness. That incremental CE comparison examines whether the additional costs achieve an additional effect, which makes the SBWC incrementally more cost-effective. The SBWC program is estimated to annually save approximately \$1 per percentage weight loss per person over the PRT-exercise-only remediation from both the Command and Navy perspectives. Thus, the estimated annual impact would be a savings of \$675,198 with an investment of \$24,363 twice annually, assuming the probabilities of PRT failures and discharges are maintained. These findings were sustained under sensitivity analysis that tests the influence of the assumptions and inclusiveness of the CEA.

This study documents the average cost-effectiveness of the Navy's current Command Level PRT exercise-only program and the improved cost-effectiveness when that intervention is standardized and augmented with nutrition and behavioral modification interventions (SBWC), even while onboard the Navy's sea-going vessels. These findings are based on conservative assumptions and valuation techniques at each stage of the analysis underlying the comparisons. The consistent dominance of the SBWC over the PRT-exercise-only remediation across both Command and Navy perspectives further confirms the finding that SBWC should be implemented Navy-wide. (1)

Methods and Results, Obesity-Related Hospitalization Costs

The objective to estimate the cost to the U.S. Navy for obesity-related hospital admissions was examined by: 1) the inpatient utilization associated with obesity; 2) the rank order, probability, and total facility costs of obesity-related Diagnostic Related Groups (DRGs); and 3) the expected inpatient expenses. The analysis was structured by age groups (18-24, 25-34, 35-44, and 45-64 years old) that are commonly used in the Navy's central health care data system. Stratification by age also permitted documentation of increased cardiovascular disease incidence over life span. Detailed hospital event data were extracted from the Retrospective Case Mix Analysis System (RCMAS). The RCMAS database provides several descriptors of the admission and associated treatment including up to twenty diagnostic classifications (ICD9 codes), the diagnosis related group (DRG) for the admission, the length of the hospital stay, and procedures (ICD9 codes) delivered during the admission. Having a CVD diagnosis ICD9 code in the primary or lower-order diagnosis fields for a 1995 or 1996 admission identified patients who were entered into this analysis. The candidate CVD diagnoses were determined from both empirical evidence and expert judgment.

Among patients admitted with an ICD9 of CVD as one of the diagnoses, advancing age was associated with more admissions for chest pain and circulatory disorders. Coronary bypass began to appear in the top 5 obesity-related DRGs in the 45-64 year old age group. The number of CVD admissions in that oldest age group drops markedly, which is consistent with military retirement and the number of personnel of that age who remain on active duty. Expected facility costs per obesity-related admission for active duty Navy personnel increased by age group from \$3,328 for 18-24 year olds to \$5,746 for 45-64 year olds. Annual avoidable inpatient = for the Navy was estimated to be \$5,842,627 for the top ten obesity-related DRGs.(2)

Clinical Significance

Results of the standardized shipboard weight control program support the ability to conduct multifaceted weight control programs on deployed naval vessels and are important to the Navy because of their potential to positively impact Navy policy on obesity treatment. Through extension and replication, the effect of this program conducted on other types of operational platforms and at shore-based facilities may result in a feasible and effective approach to improving the health and well-being of the Navy's service members. Pilot data from a refinement of this shipboard weight control program that uses indigenous shipboard personnel rather than a Navy dietitian to conduct the intervention are very promising.

Obesity extracts a large economic cost from the Navy in terms of health care services (inpatient and outpatient) and premature discharges for failure to maintain body composition and physical readiness standards. These costs are high in aggregate, and no less significant at the individual level. Importantly, these costs are avoidable if innovative and cost-effective remedial treatments are implemented. Improvements to the Navy's physical readiness

remedial program and other health promotion interventions that might reduce weight, cardiovascular risks and obesity-related health care and personnel discharges should be examined rigorously before adoption. Those that are efficacious and cost-effective should be implemented to reduce the public's economic burden.

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6. THE TRIPLEX L²E³AN PROGRAM: A CURRENT UPDATE

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As obesity has effected the civilian population over the last two decades, so have the rates of obesity increased in the U.S. military. In 1994, many service members were administratively discharged for their inability to maintain weight standards. Moreover, as the armed services downsizes, loss of trained and skilled personnel due to weight problems has taken on increased importance. As a result of the problems associated with obesity and other behavioral disorders and lifestyle diseases (such as obesity, essential hypertension, type II diabetes and hyperlipidemia). Tripler Army Medical Center developed a healthy lifestyle program to treat any of these diseases. Coined the **L²E³AN PROGRAM** (emphasizing healthy Lifestyles, health for Life, Exercise, Emotions, Expectations that are reasonable, Attitudes and N2E³AN Program and its innovative telemedicine web page offers promise for the treatment of obesity and its related diseases. The authors of this study will continue to develop similar programs at other military medical facilities and hope to find innovative ways to treat obesity.

7. ARMY WEIGHT MANAGEMENT INSTRUCTION TO MASTER FITNESS TRAINERS (MFTS)

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INTRODUCTION

The United States Army Physical Fitness School (APFS) is located in Ft. Benning, Ga., Home of the US Army Infantry Training Center. The APFS is responsible for writing operational physical fitness doctrine, conducting physical fitness research, and providing physical training support to the Army. Writing the fitness doctrine includes composing, staffing, reviewing and publishing Field Manual 21-20, *Physical Fitness Training* and the on-going responsibility of updating changes and authoring articles for Army publications.

The APFS also conducts operational research. For example, APFS personnel designed the protocol and administered the research procedures to set the 1995 Army Physical Fitness Test (APFT) Standards Update Study, 1997 APFT Validation Study, 1998 Entrance and Exit Requirements for the Army Basic Combat Training (BCT) Fitness Training Units, 1999 Impact of the New APFT Standards on Attrited Soldiers from BCT, and 1999 Upper body Strength Needed to Complete Army Airborne Training.

Providing training support to the Army includes conducting many mid-length and short physical training courses. The most visible course is the Master Fitness Trainer (MFT) course, a 101-hour course that begins with some basic anatomy, muscle and exercise physiology, strength, flexibility, and cardiorespiratory training techniques. Additionally, other topics include nutrition, unit and individual exercise prescriptions, and teaching the MFTs the Army Weight Control Program.

MFT INSTRUCTION

The agenda of this presentation is to provide the audience with an overview of the Army Weight Control Program instruction provided to the MFTs, and the role of the MFT in the Army Weight Control Program. This instruction is segmented in two parts; Army Regulation (AR) 600-9 (4 hours), and nutrition (4 hours). The purpose of the regulation is to establish policy and procedure for the implementation of the Army Weight Control Program. The objectives include; meeting the physical demands of their duties under combat conditions, and presenting a trim military appearance at all times. The commanders' responsibilities include the following: program implementation, personnel monitoring, exercise programs, and providing education programs to the soldiers enrolled in the Army Weight Control Program.

The MFT's have an integral role in the Army Weight Control Program. They conduct weight-ins when the APFT is administered, i.e., biannually. Soldiers are placed in the Army Weight Control Program when they exceed the set weight for their height as determined by the AR 600-9 Screening Table Weight. The MFT's role is to assess the identified soldiers, write an exercise prescription, assist with the maintenance of personal weight and body composition goals, assist the commander in the development of proactive fitness programs and to provide dietary and nutritional guidance. **Soldiers are monitored monthly, weigh-ins are conducted by the commander or designee, body fat is evaluated regularly. Satisfactory progress is 3-8 lbs. / month weight loss**

Identified soldiers are removed from the program by the commanders and supervisors when body fat standards are met, and the AR 600-9 Screening Table Weight is not used for removal. When there is unsatisfactory progress, the soldiers are screened for a medical condition. When there is a medical condition, hospital personnel provide medical treatment. When there is no medical condition, Army administrative personnel bar the soldier from reenlistment, other favorable actions and administrative separation procedures begin.

Soldiers are monitored for 36 months upon removal from the program. If a soldier again exceeds body fat with in 12 mos. of removal date, the soldier is separated. If soldier again exceeds the body fat standards after the 12th month, but within 36 mos., the soldier allowed 90 days to meet the standard.

The Army Weight Control Program uses separate circumference measurement sites for females and males. The males' measurement sites are at the abdomen at the level of the navel and around the neck, just below the larynx. The females' measurement sites are: at the hip where the point of the gluts protrude the most; forearm at the largest point; neck just below the larynx; and the wrist between the bones of the wrist and the forearm.

During MFT instruction, APFS instructors teach the MFT students Lean Body Mass and Target Weight Formulae, i.e., Lean Body Mass = Present Body Weight X (1 - % present body fat) and Target Weight = Lean

Body Mass ÷ (1 - % Target body fat). The concept of energy balance is presented. For example these formulae are taught to the MFT students:

Energy Input = Energy Output = Stable Body Weight;

Energy Input > Energy Output = Increase Body Weight;

Energy Input < Energy Output = Decrease Body Weight.

During MFT instruction, APFS instructors teach the MFT students energy balance manipulation for effective weight loss. These include:

- Reduce caloric intake below daily energy requirements;
- Maintain caloric intake & increase caloric output through exercise;
- *Ideally*, reduce caloric intake below daily energy requirements & increase caloric output through exercise.

To determine weight maintenance formula, the activity factors of sedentary: 12 - 14 calories per lb. (desk job, little/no exercise), active: 15 calories / lb. (regular exercise program)and highly active: 16 -18 calories / lb. (physically demanding work and/or high level of physical training) are used. MFT instruction presents safe minimum calorie intakes of no less than 1500 kcal for males and no less than 1200 kcal for females. Nutrition in the MFT Course is directly linked to weight management through the dietary guidelines; nutrients, class, characteristics, function; interpreting food labels, conducting a dietary recall, and calculating of per cent calories from CHO, protein and fat.

Mandatory requirements for nutrition education prior to or shortly after enrollment in Army Weight Control Program includes instruction by a registered dietitian in which soldiers learn proper diet for weight control. Follow-up with the R.D. is encouraged; however, it is not required under the provisions of AR 600-9.

SUMMARY

In summary, the overview of Army weight management instruction to Master Fitness Trainers includes; program implementation, personnel monitoring, exercise programs, and education programs.

8. THE GENETICS OF OBESITY

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Understanding of the genetic influences on obesity in humans has increased at a tremendous rate in the recent past. It is now well established that obesity has a significant genetic component. In humans approximately 50 to 70% of the within population variation in a variety of obesity-related phenotypes appears due to within population genetic variation. Several single gene defects leading to massive obesity have been found in animal models but very few humans appear to be obese due to mutations in single obesity genes. As a result investigators are actively searching for oligogenic influences on human adiposity.

One of the greatest challenges in biomedical research today is the elucidation of the underlying genetic architecture of complex phenotypes such as obesity. In contrast to simple Mendelian disorders, in which there is generally a one-to-one relationship between genotype at a single locus and the presence or absence of the disorder, obesity rises as a result of numerous behavioral, environmental, and genetic factors (i.e., obesity is multifactorial in origin).

Twin, adoption, and family status have long established that an individual's risk of obesity increases when he/she has relatives who are obese. In fact, it has been shown repeatedly that a substantial portion (\approx 40 to 70%) of the variation in obesity related phenotypes, such as body mass index (BMI), sum of skinfolds thickness, fat mass, and leptin levels, is heritable [Comuzzie et al., *Amer. J Hum Biol.*, 5, 725 (1993); Comuzzie et al., *Int J Obes.* 18, 413 (1994); Comuzzie et al., *J.Clin.Endocrinol.Metab.* 81, 587 (1996)]. Finally, numerous segregation analyses (studies evaluating the evidence and mode of transmission for a major gene based on observed patterns of phenotypic inheritance among related individuals) have provided evidence that among the genes influencing the expression of these obesity-related phenotypes there are at least a few with relatively large measurable contributions. For example \approx 40% of the variation in fat mass has been attributed to the effects of such a major gene [Comuzzie et al., *Genet Epidemiol.*, 12, 475 (1995); Rice et al., *Am J Hum Genet.*, 52, 967 (1993)]. These segregation analysis reveal that there are genes with major effects on the amount and distribution of body fat, and that these genes appear to exert their affects across various ethnic populations. In addition, segregation analysis of longitudinal changes in percent body fat over a 5-year period has yielded evidence for a major gene effect [Comuzzie et al. *Genet. Epidemiol.*, 17:221-222 (1999)].

Most recently the emphasis has shifted from the question of whether human obesity has a genetic component, to the question of which specific genes are responsible. Currently the major effect in the search for specific genes contributing to human obesity is based on the use of genome scanning. In a genome scan, linkage analysis is conducted using a series of anonymous polymorphisms, spaced at a relatively constant interval over the entire genome (for example \approx 350 – 370 markers with an average spacing of 10cM), to identify quantitative trait loci (QTLs) affecting the phenotype under study. In contrast to the typical candidate gene approach, with genome scanning there are no *a priori* assumptions about the potential importance of specific genes or chromosomal regions. Instead the results of the scan are used to identify candidate chromosomal regions, or in some cases positional candidate genes, which then become the focus of more intensive follow-up analyses. A positional candidate gene differs from a traditional candidate gene in that it is only considered as a candidate after the establishments of its proximity to a quantitative trait locus (QTL) identified via linkage in a genome scan. Thus, the genomic scan approach offers the potential of identifying previously unknown, or unsuspected genes, influencing the phenotype of interest.

In the case of our work in the San Antonio Family Heart Study (SAFHA), ten extended families of Mexican Americans (representing 459 individuals comprising 5667 relative pairs ranging from parent-offspring to double 2nd cousins) were evaluated for several obesity related phenotypes in a 20 cm genomic span [Comuzzie et al., *Nat Genet.*, 15, 273 (1997)]. Significant linkages were detected for QTLs on chromosome 2 (\approx 74 cm from the tip of the short arm) and chromosome 8 (\approx 65 cm from the tip of the short arm) and leptin levels (LOD scores = 4.3 and 2.2, respectively). A significant linkage was also detected between fat mass (FM) and the chromosome 2 QTL (LOD score = 1.9). Multi-point analysis of the leptin linkages increased the LOD score to 4.95 for the QTL on chromosome 2 and 2.2 for the chromosome 8 QTL [Comuzzie et al., *Nat Genet.*, 15, 273 (1997).] In the case of the chromosome 2 linkages, this QTL is estimated to account for 47% of the variation in serum leptin levels and 32% of the variation in FM. Recent, follow-up work in this region of chromosome 2 has now boosted the LOD score for the leptin linkage to 7.5 [Comuzzie et al., *Jour. Clin. Endocrinol. & Metab.*, 84, 3187 (1999)].

The areas of linkage on chromosome 2 and chromosome 8 contain strong positional candidate genes for obesity. For example, the region on chromosome 2 encompasses *POMC*, which codes for the prohormone pro-opiomelanocortin, which is post-transcriptionally processed to produce a number of hormones in the hypothalamic-

pituitary axis such as melanocyte-stimulating hormones and adrenocorticotropic hormone (ACTH) which have long been suspected of being involved in obesity. *POMC* was originally identified as a candidate gene based on its location, and its gene product has now been implicated in appetite regulation [Boston et al., *Science*, 278, 1641 (1997); Seeley et al., *Horm Metab Res.*, 28, 664 (1996); Seeley et al., *Nature*, 390, 349 (1997); Schwartz et al., *Diabetes*, 46, 2119 (1997)]. We have now identified two polymorphisms in *POMC* that are associated with variation in leptin levels in this population of Mexican Americans [Comuzzie et al., *Jour. Clin. Endocrinol & Metab.*, 84, 3187 (1999)]. The region of linkage on chromosome 8 encompasses *ADRB3*, for the β-3-Adrenergic receptor, which represents a previously identified candidate based on its physiological activity with respect to the regulation of energy expenditure. Although the cumulative evidence of linkage between the well-known tryptophan to arginine mutation (trp64Arg) in *ADRB3* and BMI is weak, the argument that *ADRB3* is a human obesity gene has been strengthened by the follow-up analyses in this same sample of Mexican Americans [Mitchell et al., *J Clin Invest.*, 101, 584 (1998)]. These analyses have revealed an association between *ADRB3* variants and BMI, FM, and waist circumference after first continuing on the stronger QTL signal on chromosome 2.

In addition to our work in humans, our preliminary genome scanning efforts in primates (i.e. baboons) have also begun to reveal additional QTLs with significant effects on obesity-related phenotypes. At present, we have detected suggestive evidence of linkage for QTLs influencing body weight (LOD =2.12) and fat cell number (LOD =2.15). In both cases, the confidence intervals surrounding these two QTLs contain two strong positional candidates. The QTL for body weight is located near *NPY* and QTL for fat cell number is near *IGF-1*.

While there are undoubtedly single genes that produce massive phenotypic effects on obesity-related phenotypes in isolated individuals or families, the identification of at least a few loci with common alleles with measurable effects on the general population has significant implications for public health. Work to date suggests the existence of roughly a dozen genes with measurable effects of the expression of obesity-related phenotypes at the population level. As a result, there is now not only strong evidence for a genetic component in the variation of body weight across individuals, but we are beginning to identify specific genes with measurable effects.

9. THE PHARMACOTHERAPY OF WEIGHT LOSS, AND IT'S POTENTIAL APPLICATION IN THE MILITARY SETTING

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General:

Only a small percentage of patients are able to achieve their weight goals, an even smaller percentage are able to maintain such weights over time. The majority of those who lose weight return to their initial obese state or gain more (Turner, Lori W. et. al: Preventing Relapse in Weight Control: A Discussion of Cognitive and Behavioral Strategies. *Psych Reports*, 77: 651-656, 1995).

This is particularly well illustrated by Kramer (Kramer, F. Matthew, et. al: Long-Term Follow-up of Behavioral Treatment for Obesity: Patterns of Weight Regain among Men and Women. *Int. J of Obesity*, 13:123-136, 1989) who, in a 5-year study, demonstrated that only 5.3% of women, and 0.9% of men were able to maintain all the weight that they had lost. Forty percent in general gained weight at least to baseline levels or above at some point during the follow-up.

The "bright" side of Kramer's study was that there were measurable residual benefits from behavioral weight management programs 4-5 years beyond termination of initial treatment —18.5% maintained at least half of their losses throughout follow-up, and 34% kept off at least 25%.

The view that short-term interventions will cure a chronic condition has hampered the development of methods for controlling weight. The major challenge facing obese patients and health care providers is to improve the ability to sustain, rather than to achieve, weight loss.

The definition of success that is applied in evaluating weight-loss programs should be broadened and made more realistic based on the research to date that small weight losses can reduce the risks of developing chronic diseases. Specifically, the goal of obesity treatment should be refocused from weight loss alone to weight management, achieving the best weight possible in the context of overall health. In contrast to weight loss, the primary purpose of weight management is to achieve and maintain good health. This concept includes weight loss but is not limited to it (Thomas 1995).

In this light pharmacotherapy of obesity must be seriously considered in the acute, and chronic, management of this disease.

Anorectics and Weight Loss/Weight Maintenance

The following are the three currently available classes of anorectics:

- 1) Catecholamine like agents
- 2) Serotonin reuptake inhibitors
- 3) Lipase inhibitors

The following two additional classes are undergoing research:

- 1) Leptin
- 2) Metabolic enhancers

The Catecholamine-like agents include Phentermine (Fastin/Adipex), Diethylpropion (Tenuate), and the Phenopropanalarnines (Accutrim & Dexatrim). These are the oldest agents available and are very effective. Sympathomimetic amines have actions that include symptoms similar to the fight or flight syndrome, to include CNS stimulation and anorexia. This is also the source of most of the medication's side-effects which include insomnia, palpitations, tachycardia, dry mouth, dizziness, euphoria and headache, elevation of BP, & tachycardia,. The average weight loss is around 10 Kg at 6 months. Studies of greater than 6 months are lacking with the exception of the combination Phen-Fen, which was studied out to 3½ years, and will be discussed later.

The rate of weight loss associated with the use of phentermine tends to be greatest in the first weeks of therapy, and decrease with succeeding weeks, to an eventual plateau around the 6th month of treatment. Use of these agents is contraindicated in advanced ASCAD, moderate to severe HTN, hyperthyroidism, glaucoma, agitated states, pregnancy, and in eating disorders.

The primary side effects found with the drug Orlistat are: Fecal urgency - 10.0 to 29.0%, and Fecal incontinence - 5.0 – 11.8%. Both high fiber meals, and low-fat diets have reduced the frequency of intestinal

complaints by producing fewer liquid or oily stools. In some the fat-soluble vitamins (A, D, E, K, and Beta-carotene) are reduced, and need to be supplemented (2 hours before or after use of Xenical).

Since Orlistat undergoes minimal systemic absorption, the primary drug interaction concern has been its influence on the absorption of co-administered drugs. Orlistat has been found to increase the half-life of farosernide and the time to peak concentration of sustained-release nifedipine (adalat/Procardia XL), although these increases were not considered to be clinically significant. The concomitant administration of pravastatin and orlistat increased pravastatin's bioavailability and lipid lowering effect modestly. The combination has also been shown to increase the risk of rhabdomyolysis. Because of the decreased absorption of vitamin K, Coumadin use must be monitored closely during co-administration with Xenical.

Orlistat is contraindicated in patients with chronic malabsorption syndrome, or cholestasis, and in patients with known hypersensitivity to Xenical.

Leptin is a natural human protein produced by fat that has few or no apparent significant adverse side-effects. Currently this medication is experimental, and given subcutaneously, with its most common adverse effect being moderate skin reaction (redness, itching, swelling) at the injection site.

It appears to act as a chemical messenger from fat cells to the brain to indicate the level of fat in the body. By complex endocrine controls that may include decreasing levels of a hormone called neuropeptide Y, the Leptin tells the brain to decrease fat intake, and increase energy use. Theoretically, the lateral hypothalamus of an individual taking Leptin would not realize that the body is losing weight, and compensatory mechanisms would not be put into effect. In animals it not only reduces food intake, but also increases basal metabolic rate with selective promotion of fat metabolism.

In contrast to the Leptin deficient lab mice upon which this was initially tested, most obese mammals have elevated plasma concentrations of Leptin and insulin, and appear to be resistant to leptin-induced anorexia. This resistance is similar to a type 11 diabetic's resistance to insulin. Thus leptin's effect in humans has not been as dramatic as in animals. It is modestly effective causing an average 16 pounds over 6 months.

Thyroid hormone is one prototype of a thermogenic drug. It produces a log-dose increase in metabolic expenditure. Pharmacological doses of thyroid hormone, however, are associated with increased breakdown of protein, increased calcium loss from bone, and an increased risk of cardiovascular dysfunction.

Interest in Triiodothyronine as a treatment for obesity has been revived by the observation that T3 falls in very low-calorie diets (as well as in anorexics and bulemics) and the administration of T3 can prevent the decline in metabolic rate that occurs. However, the reduction in T3 when dieting may be a compensatory effort by the body to conserve visceral proteins since it has been found that up to 75% of the extra weight lost on T3 replacement can be accounted for by the loss of fat-free mass.

Brown fat stimulants show much promise in the future, but are only in the beginning phases of animal research. Currently there are no agents on the market that have been proven to increase the metabolism of dieting patients (despite all the "health food" claims to the opposite).

Barriers To Drug Treatment:

The view that obese people need "only to close their mouths" has caused us to demand a higher standard for medications used in treating obesity than we do for treatments of any other chronic condition. In many conditions we accept the condition will relapse following the cessation of therapy. Even in the absence of cure, patients and physicians still view ocular hypotensive agents, anti-hypertensive agents, cholesterol-lowering medications, antidepressants, and H2-blockers as valuable. However the failure of a medication to "cure" obesity is found to be unacceptable. The anorexiants are labeled as failures when the patient regains weight after treatment has ended.

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10. USE OF PHARMACOLOGICAL AIDS IN WEIGHT MANAGEMENT

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Obesity is now recognized as a chronic disease. Although the NIH Consensus Conference declared such as early as 1985 (1), it was not until the identification of the leptin gene (2) and the other single-gene mutations causing rodent obesity that chronic disease model of obesity gained wider acceptance. Like hypertension and other chronic medical conditions, obesity will, in all likelihood, require chronic pharmacological treatment in a stepped-care approached when diet and lifestyle modification alone area inadequate.

Treatment of any medical condition involves weighing risks of the disease against the risks and benefits of treatment. Evidence based national guidelines have evaluated these risks and benefits. They suggest that medications be a consideration in obesity treatment programs for individuals with a BMI greater than 30 kg/m² or greater than 27 kg/m² when complicated by diabetes or other medical conditions likely to improve with weight loss (3). Although individuals less than 30 years of age have a lower mortality risk from obesity than individuals over 50, this difference is not clinically significant until the BMI exceeds kg/m² (4).

Although obesity is now recognized in the medical community as a chronic disease, the public is much more concerned about the cosmetic aspects of being obese. The average American woman has a BMI of 24 kg/m² while the average fashion model, the ideal to which many women aspire, has a BMI of 16 kg/m². The upper limits of military standards for weight correspond to a BMI of 22-25 kg/m² for women and 23-28 kg/m² for men. The stated reasons for these standards are to maintain a trim military appearance.

It could be argued that, like national guidelines for obesity treatment, military weight standards should be based upon medical risks rather than cosmetic considerations. Since one-third of the American population has a BMI greater than 27 kg/m², the military may be losing the services of many health and talented people who would like to serve in their nation's military service. The military service draws its ranks disproportionately from minority groups. Minority groups bear a disproportionate obesity burden making the potential loss of talent to the military even greater (3).

The basis of any weight loss program is diet and lifestyle change. When these modalities by themselves are not sufficient, and the BMI is 27-30 kg/m² depending on the presence or absence of co-morbid diseases, medications for obesity can be justified. Therefore, except in the case of unequal application of military standards, individuals with this degree of obesity will be discharged from the military service. Thus, the indications for obesity medications in the military are vanishingly small.

There are two medications approved for the long-term treatment of obesity. Sibutramine is a norepinephrine and serotonin reuptake inhibitor that inhibits food intake centrally, and orlistat is an inhibitor of pancreatic lipase that functions within the intestinal lumen. Both drugs give a 7-10% weight loss over six months that is maintained at one year (5,6). Orlistat gives a drop of cholesterol in excess of that predicted from the weight loss it induces, but sibutramine does not give the blood pressure drop expected from weight loss. In other respects, cardiovascular risk factors are reduced in proportion to weight loss.

If serotonin reuptake inhibitors are excluded from the military formulary, sibutramine may not qualify for use in the military. Although generally well tolerated, orlistat can give gastrointestinal symptoms such as abdominal cramps, soft stools and fecal urgency. If these symptoms were to occur in a military field exercise, training disruptions could result. Due to the loss of fat-soluble vitamins in the stool, a vitamin supplement is recommended with orlistat. The only other prescription medications indicated for weight loss are scheduled by the DEA, since all of them have at least some potential for abuse. In addition, they have only approved and tested for use over periods up to 12 weeks. Therefore, the approved prescription medications for weight loss have little utility in the military service.

The criteria for using non-prescription drugs in the treatment of obesity have received much less attention from groups forming guidelines for obesity treatment. Phenylpropanolamine is sold without a prescription for the treatment of obesity. Ephedrine with a methylxanthine is sold without a prescription for the treatment of asthma, but is approved and sold for the treatment of obesity in Denmark. At least in the 1970's, phenylpropanolamine was on the military formulary as a decongestant and ephedrine with theophylline was on the military formulary for asthma. These two pharmacological approaches deserve further comment.

Phenylpropanolamine is approved for the short-term treatment of obesity (less than 12 weeks). Phenylpropolamine is a central alpha- 1 adrenergic stimulator that has no addictive potential and gives weight loss equivalent to prescription anorectic drugs during the first 4 weeks of treatment. The longest study with this medication lasted 20 weeks and was small, but the phenylpropanolamine group lost 6.5% of their body weight (7). Phenylpropanolamine has a remarkable record of safety. It gives a small increase in blood pressure that is statistically, but not clinically, significant. The dose approved to treat obesity is 75 mg/d. Phenylpropanolamine is

approved for use without a prescription in cough and cold preparation in twice that dose. Short-term treatment of a long-term disease is not logical, but it is unlikely that approval of phenylpropanolamine for the long-term treatment of obesity will be pursued unless financed by the government, since the drug is no longer covered by patent. The wholesale price of one month of treatment with phenylpropanolamine is less than \$0.50 per month.

Caffeine and theophylline are both methylxanthines. Two milligrams of caffeine has the potency of 1 milligram of theophylline, but they are otherwise equivalent. Ephedrine 24 mg combined with 125 mg of theophylline is sold without a prescription for the treatment of asthma in the dose of one or two tablets three times a day. This combination was the first-line treatment for asthma in both adults and children in the 1970's. Caffeine 200 mg with ephedrine 20 mg given three times a day is an approved obesity medication in Denmark. In a trial conducted in Denmark the combination gave a 16% weight loss over 6 months that was maintained with continued treatment at one year (8). Caffeine and ephedrine is also inexpensive. A month of treatment at wholesale prices runs less than \$2.50, but not being covered by patent is unlikely to be approved for the long-term treatment of obesity without government subsidy.

Not only are the risks and benefits of using even non-prescription medications to treat obesity in a population of healthy individuals with a BMI less than 28 kg/m^2 unclear, but dietary treatments may have greater long-term efficacy than the available obesity medications. A recent study lasting 3 months demonstrated that a 1200-calorie balanced diet was many times more effective in causing weight loss when it included calorie-controlled portions substituted for two meals and two snacks per day compared to the standard 1200-calorie diet utilizing an exchange system (9). Individuals replacing one meal and one snack with calorie controlled portions following this 3-month weight loss program lost 9% of their body weight at one year and 11% at two years.

Studies with sibutramine, orlistat and phenylpropanolamine give a 6-10% weight loss at one year. The military appears to be in an ideal position to exploit this new information. Meals Ready to Eat (MRE's), the military field rations perfected through military nutrition research, could easily be modified for a weight loss program using a 1200-calorie diet and calorie controlled portions.

Epidemiological studies such as the Framingham study show a higher mortality in those individuals losing weight. Since the risk factors for cardiovascular disease improve with weight loss, this finding has remained a paradox. Recently, Allison et al. reanalyzed the Framingham and Tecumseh studies and demonstrated that mortality increases by 29% for every standard deviation (4.6 - 6.7 kg) of weight loss but decreases 15% for every standard deviation of fat loss (4.8 - 10 mm of skin fold thickness) (10). This suggests that losing lean tissue during weight loss carries a mortality risk. Therefore, the ideal weight loss medication should cause fat loss and spare lean tissue.

When people gain weight, 75% of the weight gain is fat and 25% is lean tissue. Weight is lost with diet or appetite suppressing medications in these same proportions of fat and lean tissue. Exercise and caffeine with ephedrine, both of which increase catecholamine turnover, induce a selective loss of body fat. Not only does a selective fat loss have the potential to impact in a positive way upon mortality risk, but preservation of lean tissue is likely to reduce injury and contribute positively to the fighting strength in a military setting.

In conclusion:

- The military may be paying a price in lost talent for its stringent weight requirements aimed at maintaining a trim military appearance.
- Given that military personnel have a BMI less than 28 kg/m^2 , there is little place for the pharmacological treatment of obesity in the military.
- Caffeine and ephedrine give preferential fat loss and might deserve further consideration as a military obesity treatment if military weight standards are liberalized.
- Calorie-controlled portions combined into a 1200-calorie balanced diet may give better sustained weight loss than presently available obesity medications, and these calorie-controlled portions could be created for the military through modification of existing field rations (MRE's).

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11. EFFECTS OF EXERCISE, DIET, AND WEIGHT LOSS ON LIPID METABOLISM IN WOMEN

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Consensus has been reached within the past 5 years, that sedentary status and overweight are each independent risk factors for coronary heart disease (CHD) in adults, despite their strong associations with other established CHD risk factors, including low levels of high density lipoprotein (HDL)-cholesterol, elevated triglycerides, hypertension, and diabetes.^{1,2} Many observational and prospective cohort studies have shown that physical inactivity^{1,3-5} and excess body weight^{2,6} are each associated with a 2-3 fold increased risk of CHD in women compared to active and/or normal weight women. In addition to low HDL-cholesterol, it is generally accepted that elevated low density lipoprotein (LDL)-cholesterol is a major CHD risk factor in women, and that a diet high in fat, especially saturated fat, raises LDL-cholesterol levels; furthermore, adoption of a low-fat diet is recommended as the initial step in managing an adverse lipoprotein profile, before resorting to a pharmacological approach⁷. The role of exercise, diet, and weight loss on lipid metabolism is, therefore, of major interest for women.

Recent national surveys report that over a third of U.S. women aged ≥ 45 years participate in no leisure-time physical activity and less than 20% participate in regular, sustained physical activity at the recommended level (≥ 5 days per week for ≥ 30 minutes)¹; while nearly two-thirds of women aged ≥ 50 years are overweight ($BMI \geq 25.0 \text{ kg/m}^2$), half of whom are obese ($BMI \geq 30.0 \text{ kg/m}^2$).² It has been suggested that adoption of the recommended level of physical activity could reduce the risk of coronary events by 30-40% in women⁵ and that as much as 70% of the coronary disease observed in obese women and 40% of that among women overall is attributable to overweight and is therefore preventable.⁶ A combined intervention of caloric reduction (emphasizing reduction of dietary fat, especially saturated fat, simple carbohydrates, and alcohol), physical activity, and behavior therapy, provide the most successful therapy for weight loss, (with a goal of losing 10% of body weight over a period of about six months), and weight maintenance.²

Although trials of exercise, diet, or weight loss for prevention of CHD morbidity or mortality have not been completed, to date, the effects of diet and exercise by initially sedentary or overweight women on specific CHD risk factors, such as HDL- and LDL-cholesterol, have been reported in several randomized, controlled clinical trials⁸⁻¹⁵. While several such studies have reported an HDL-lowering effect of a low-fat diet in women, when LDL-cholesterol is lowered, or no significant lipoprotein improvements of diet alone, for women with initially unfavorable lipoproteins, the addition of exercise to the low-fat diet has been shown to result in significantly greater lipoprotein improvements in both pre- and postmenopausal women, even in the absence of greater weight loss with the addition of exercise to the diet.^{9, 14, 15} There is little evidence, however, that aerobic or resistance exercise alone can improve obesity-related lipoprotein problems; therefore, diet, and if appropriate, weight loss, should be a focus of intervention as well.¹⁵ In general, these trials suggest that a lifestyle approach (diet, exercise, and weight loss) can substantially reduce CHD risk in women, by reducing body weight and improving HDL- and LDL-cholesterol, triglycerides, blood pressure, and blood glucose.

Physical activity need not be of high intensity to reduce CHD risk substantially^{1,5} and lower-intensity activity may result in better adherence over the long-term.¹² For weight loss, women randomized to three 10 minute bouts appeared to do better than those randomized to one 30 minute bout¹⁶. Finally, for both improvement in cardiovascular fitness¹⁰ and in weight loss¹⁷, home-based programs seem to be more effective than group-based programs for women, although this will certainly depend on the individual. Whether lifestyle in combination with hormone replacement therapy (HRT) is superior in improving lipoproteins in postmenopausal women, compared to HRT alone is unknown, but is being explored in the Women's Healthy Lifestyle Project.¹⁸

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12. REPRODUCTIVE HEALTH ISSUES IN FITNESS AND WEIGHT CONTROL PROGRAMS

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Many women who restrict their diets or who exercise for fitness or weight control experience a loss of menstrual cycles. In such amenorrheic women, the normal monthly rhythms of estrogen and progesterone are absent, indicating a complete suppression of ovarian follicular development, ovulation, and luteal function. (1) In addition to infertility, these estrogen-deficient women suffer an irreversible skeletal demineralization (2) leading to osteoporosis and fractures (3-5). Among athletic women, spinal bone mineral density is negatively proportional to the number of menstrual cycles missed (6).

The proximal cause of these menstrual disorders is the slowing and disorganization of the pulsatile secretion of luteinizing hormone (LH) by the pituitary gland (1), which reflects the disorganized secretion of gonadotropin-releasing hormone (GnRH) by the hypothalamus in the brain (7). The influence of behavioral and environmental factors on the regulation of GnRH has been controversial and the subject of much research in recent years.

Early reports of amenorrhea in physically active women were attributed to low body fatness (8), but many observational studies have accumulated evidence to disprove this hypothesis (9,10). Nevertheless, this hypothesis was rejuvenated with the discovery that the adipose tissue hormone leptin is suppressed in amenorrheic women and that neurons with leptin receptors in the arcuate nucleus influence GnRH secretion via POMC and NPY pathways (11). More recently, however, the secretion of leptin by adipose tissue has been found to be acutely and profoundly responsive to energy availability (12,13), and even more specifically to carbohydrate availability (14,15).

Most current research into the mechanism of menstrual disorders in exercising women is focussed on two competing hypotheses. The energy availability hypothesis holds that the reproductive system is disrupted by an as yet undetermined mechanism when physically active women fail to consume enough dietary energy each day to match their daily energy expenditure (16). A recent variant of this hypothesis holds that reproductive function depends specifically on glucose availability, since the brain relies on glucose for energy (17,18). The competing stress hypothesis holds that exercise activates the hypothalamic-pituitary adrenal (HPA) axis and that the hormones secreted by this axis disrupt the reproductive system.

Because the HPA axis has a gluco-regulatory role, we designed experiments to measure the independent effects of energy availability and exercise stress on regularly menstruating, habitually sedentary women. Until these experiments, all investigations into the influence of exercise on reproductive function since those of Selye in the 1930's (19) had confounded the "stress" of exercise with its impact on energy availability.

So far, these experiments appear to have taught us three lessons. First, LH pulsatility depends on energy availability, defined as dietary energy intake minus exercise energy expenditure, and not on either exercise stress or on energy intake or energy expenditure alone. In our experiments, exercise had no effect on LH pulsatility beyond the impact of its energy cost on energy availability (20). By increasing dietary energy intake in compensation for exercise energy expenditure, we prevented the apparent disruptive effects of exercise stress on LH pulsatility.

Second, in women the disruptive effects of low energy availability appear to occur at a threshold of energy availability between 20 and 30 kcal/kg LBM/day. (In the women studied, 30 kcal/kg LBM/day corresponds to approximately 1350 kcal/day.) For energy availability above 30 kcal/kg LBM/day, alterations in metabolic hormones maintain approximately normal levels of plasma glucose and ketones. Below 30 kcal/kg LBM/day, however, even larger alterations of metabolic hormones are unable to maintain normal plasma levels of these substrates, and effects on LH pulsatility begin. Below 20 kcal/kg LBM/day, the responses of certain metabolic hormones, such as insulin-like growth factor I(IGF-I)/insulin-like growth factor-binding protein-1 (IGFBP-1) and leptin, appear to have reached their limit while the responses of other metabolic hormones, such as cortisol and T₃, become exaggerated. Nevertheless, these exaggerated responses are unable to prevent further alterations in the metabolic substrates and LH pulsatility. Thus, alterations in LH pulsatility appear to be more closely associated with metabolic substrates than with metabolic hormones.

The third lesson currently emerging from these experiments is that the effects of low energy availability on LH pulsatility appear to be smaller in men than in women. Extensive observational field studies have indicated that in mammals reproductive function continues in males under conditions in which it is completely blocked in females (21,22). In our experiments at 10 kcal/kg LBM/day, effects of low energy availability on LH pulsatility appear to be blunted in men compared to women, so that we expect to find no effects in men at 20 kcal/kg LBM/day. That is, we expect to find that the threshold at which low energy availability disrupts LH pulsatility is lower in men than in women. At 10 kcal/kg LBM/day, the only metabolic parameters distinguishing men and women are leptin and absolute carbohydrate availability (i.e., dietary carbohydrate intake minus carbohydrate oxidation during exercise).

In summary, fitness and weight control programs can damage reproductive and skeletal health. In exercising women, reproductive health appears to depend on energy availability. Damage to reproductive and skeletal health might be avoided in fitness and weight loss programs by maintaining energy availability above 30 kcal/kg LBM/day through dietary reform alone without moderating the exercise regimen. These speculations need to be tested, though, through longer-term experiments measuring effects on ovarian function. Finally, women appear to require higher levels of energy availability than men to maintain reproductive health.

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13. OBESITY: AN INFECTIOUS DISEASE ?

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Introduction

Obesity has been called the number one public health problem in America (1). Although obesity is recognized as a disease of multiple etiologies, a virus infection as an etiological factor has been ignored until now. Five different viruses have been shown to cause obesity in animal models (2-8). Of these, we have identified 2 viruses, SMAM-1, an avian adenovirus, and AD-36, a human adenovirus that produce obesity in animals. The concept that adenoviruses cause obesity and that the virus may be linked to human obesity was developed by Dr. Dhurandhar while working with SMAM-1 virus in Bombay, India, and was pursued further by Dr. Dhurandhar when he started work at the University of Wisconsin-Madison. The work led to the discovery of the obesity promoting potential of another adenovirus, AD-36, which produced obesity in animals along with a paradoxical decrease in serum cholesterol and triglycerides levels (6). Our data described below, demonstrate that a human virus produces obesity in animal models, and that a unique syndrome consisting of paradoxically low serum cholesterol and triglycerides levels, is present in about 30% of obese humans screened who have antibodies to this human virus. Antibodies to AD-36 were present in only 5% of the non-obese subjects screened to date, suggesting that infection with this syndrome carries a high probability of association (causation has not yet been proven in humans) with obesity. The possible link between a virus and obesity in humans warrants serious investigation of the obesity promoting effect of this virus.

Adenoviruses: background information:

Adenoviruses are naked DNA viruses with icosahedral symmetry and a diameter of 65-80 nm. The American Type Culture Collection (ATCC) maintains fifty types of human adenoviruses. In humans, adenoviruses are frequently associated with acute upper respiratory tract infections, and may cause enteritis and conjunctivitis. Adenoviruses can easily be isolated from nasal swabs or from feces. Adenovirus infections are transmitted via respiratory, fomite, droplet, venereal, and fecal-oral routes. AD-36 (human adenovirus type 36) was first isolated in 1978 in Germany in the feces of a 6 yr old girl with diabetes and enteritis (9).

Review Of Experiments:

Experiments with SMAM-1: We demonstrated that chickens experimentally infected with SMAM-1, an avian adenovirus isolated in Bombay, India, produced excessive fat accumulation in the visceral depots and a paradoxical reduction of serum levels of cholesterol and triglycerides (3,4). The findings were replicated. Of 52 obese humans tested by agar gel-precipitation test, 10 had antibodies to SMAM-1 (5). These 10 individuals had a higher body weight and lower serum cholesterol and triglycerides compared to antibody negative individuals (5).

Experiments with AD-36

Animal Studies

Chicken experiments: Specific pathogen free White leghorn chickens were used for three separate experiments that are summarized below. Chickens were housed under biosafety level 2 containment and were inoculated with AD-36 virus (infected group) or the tissue culture media (Uninfected controls) at 3 weeks of age. Chickens were inoculated intra-nasally in experiments 1 and 2 and i.p. in experiment 3. Chickens in experiments 1,2 and 3 were killed 3, 5 and 16 weeks post inoculation, respectively. Food intake was not different for any of the groups within any experiment. Chickens inoculated with AD-36 in experiments 1 and 2 had significantly greater visceral and total body fat and significantly lower serum cholesterol and triglycerides compared to the controls. For example, compared to the control, the AD-36 group in experiment 2 had 128% greater visceral fat ($p < .0005$) and 46% greater total body fat ($p < .0005$). These data show that AD-36 infection reliably and reproducibly induces adiposity in chickens, which is associated with a reduction in serum cholesterol and triglycerides.

AD-36 infected group in experiment 3 had significantly greater visceral fat and the histopathological study of the brain including hypothalamic area did not show any difference in the infected Vs the control groups. Unlike some other obesity promoting viruses, AD-36 induced obesity does not appear to be due to the hypothalamic damage. Virus was isolated from the oral and the rectal swabs taken from the infected chickens 1-week post inoculation but not from the controls. Also, using capillary electrophoresis assay, AD-36 DNA was detected in the DNA isolated from the adipose tissue and the blood of some of the infected chickens screened but not from the DNA obtained from their skeletal muscles. AD-36 DNA could not be detected in any of the control chickens

screened. Absence of hypothalamic lesions and the presence of the viral DNA in the adipose tissue suggest a peripheral and not a central mechanism for the development of obesity syndrome.

Mice experiment: The obesity promoting effect of AD-36 was tested in mice as a mammal model. ICR out bred Swiss albino female mice (4 weeks old) were inoculated i.p. with AD-36 (AD-36 group), or tissue culture media (Control group) and the animals were killed 22 weeks post inoculation. Food intake was not different for the two groups. Compared to the control, the AD-36 group had 9% greater body weight ($p < .05$), 67% greater visceral fat ($p < .02$) and 30% greater total body fat ($p < .02$). Sixty percent of the mice infected with AD-36 had total % body fat weights above the 85th percentile of the control group ($p < .02$). Serum cholesterol and triglycerides in the AD-36 group were significantly lower than control by 38% and 31%, respectively. This is the first report of obesity induced by a human virus in a mammal.

Monkey experiment: This experiment was carried out to screen rhesus monkey serum for the presence of Ad-36 antibodies and to ascertain any association of such antibodies to obesity and cholesterol levels. Frozen serum samples from 15 adult male rhesus monkeys were obtained from the Wisconsin Regional Primate Research Center (WRPRC). For each monkey, the samples were drawn every 6 months for a period of 90 months and a corresponding body weight was available for each sample drawn. Monkeys were between 8 yrs to 14 yrs of age when the first sample available for this study was drawn (baseline sample) and were on an ad libitum diet. Antibodies to Ad-36 in the experiment were determined with serum neutralization assay.

During the 90-month period, all 15 monkeys showed Ad-36 antibodies at some point in time. Out of 15 monkeys, 7 monkeys were seropositive at the baseline and, therefore, not included in the analysis. These 7 monkeys were excluded from the analysis because a comparison for body weight and cholesterol between before and after the appearance of Ad-36 antibodies was not possible. The remaining 8 monkeys were seronegative for Ad-36 antibodies at baseline and became seropositive after variable periods. Body weight and serum cholesterol at 6 monthly intervals were analyzed for these 8 monkeys. Body weight and cholesterol of the 8 monkeys before turning antibody positive were compared with those after the first appearance of Ad-36 antibodies. Analysis was restricted to the 90-month period for which the serum samples were obtained.

Prior to the first appearance of Ad-36 antibody, body weight of the monkeys had plateaued for at least 18 months but increased by 10% in just 6 months after the first appearance of Ad-36 antibody. The body weight was 15% greater after 12 months and 18 months after the first appearance of Ad-36 antibody, compared to the body weight 6 months prior to the first appearance of Ad-36 antibody ($p < .03$). Serum cholesterol levels increased slightly in the 18 months before the appearance of Ad-36 antibodies. However, cholesterol levels decreased by 28% in 6 months after the first appearance of Ad-36 antibody ($p < 0.03$) and remained lower for at least 18 months after the first appearance of Ad-36 antibody. Thus, the increase in body weight and the reduction in cholesterol levels coincided with the first appearance of Ad-36 antibody in the serum. Significant changes were observed despite the small number of monkeys. This is an indirect evidence of a possible effect of Ad-36 infection on body weight and cholesterol levels. Only infecting monkeys with Ad-36 can conclusively show direct effect of Ad-36 on body weight and cholesterol levels.

Human Studies:

Human serum samples obtained from obese (Body Mass Index (BMI) $\geq 27 \text{ kg/M}^2$, N= 418) and non-obese volunteers (N=93) from 3 different sites (Wisconsin, Florida, and New York) were screened for the presence of AD-36 antibodies using serum neutralization test. At each of the three sites, prevalence of AD-36 antibodies was significantly greater for the obese compared to the non-obese subjects. Prevalence of AD-36 antibodies in 3 sites pooled together was 5% for the non-obese and 30% for the obese subjects. At each of the sites, the antibody positive obese had significantly lower serum cholesterol compared to the antibody negative obese subjects from the respective site ($p < .002$).

Conclusion

Our data show that a human adenovirus causes adiposity in animals and is strongly associated with obesity in humans. Due to ethical reasons humans cannot be experimentally inoculated with the virus and we have to depend on indirect evidence of obesity promoting effect of Ad-36 in humans. Understanding the mechanism involved in promoting adiposity and reduction in serum lipid levels caused by the virus is critical. Long-term goal of this research is to develop a vaccine to prevent Ad-36 induced adiposity.

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14. FACTORS AFFECTING LONG TERM WEIGHT LOSS/WEIGHT REGAIN

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Introduction:

Obesity has been described by the World Health Organization as an "escalating epidemic" and "one of the greatest neglected public health problems of our time with an impact on health which may well prove to be as great as smoking."¹ An estimated 97 million adults in the United States are overweight or obese, a condition that substantially raises their risk of morbidity from hypertension, dyslipidemia, type 2 diabetes, coronary heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea, and cancer.² The obesity epidemic is costing our country billions. The cost attributable to obesity amounted to 99.2 billion in 1995, of this total, 51.6 billion were direct medical costs associated with diseases attributable to obesity.² Overweight and obesity prevalence has been rising at a steady pace between 1960-1994. This increase has occurred across all ages, genders and racial/ethnic groups. A recent survey reported that 59.4% of men and 50.7% of women in the United States are overweight or obese.² Estimates show that at any one time approximately 25% of men and 45% of women are trying to lose weight.³ Of the participants who enter a behavioral weight loss program it is estimated that they will lose approximately 10% of their body weight over the course of 20-24 weeks.⁴ Unfortunately, it has also been shown that these participants also regain an average of 33% of their weight loss and typically return to their baseline weight within five years.⁴

Brief Review of Factors Affecting Long Term Weight Loss/Weight Regain

Why is America gaining weight? Consider the change in our environment over the past century. There are a greater variety of foods available. Simply consider the potato chip choices alone. There are currently a plethora of brands, varieties and flavors available to the consumer everyday and often 24 hours a day. Compare this to the turn of the century where it was common to walk to the market and purchase a 25-pound bag of potatoes to use in cooking. Food has also become more palatable. Improved manufacturing and technology have improved colors and flavors to make food appear and taste richer and more satisfying than ever before. Food has also become increasingly convenient to obtain. Gone are the days of being forced to borrow from the neighbors because the supermarkets are closed. Many supermarkets and convenience store are open 24 hours a day, ready to sell consumers the foods that contribute to weight gain. The fast food market has increasingly become a staple of American food culture over the years. Effective marketing strategies coupled with broader, inexpensive choices have made this industry a prime culprit in the American obesity epidemic. Unfortunately, with the increase in variety, palatability, convenience and availability of food, there has also been a decline in the amount of exercise performed by the average American. Sedentary desk jobs, computers, fewer safe places for exercise, more elevators and drive through restaurants are only a few of the contributors to this escalating problem.

With the changing environment and the discouraging rates of weight regain, it is imperative that we take a closer look at long-term weight maintenance and the various methods successful maintainers utilize to prevent weight gain. To get a better perspective in this area, it is appropriate to review a portion of the long-term data provided by the National Weight Control Registry (NWCR). The NWCR is a registry of individuals who have been followed in a prospective manner having been successful at maintaining significant weight losses. Participants in the NWCR have lost, on average, more than 65 pounds and maintained their weight losses for 5.7 years.⁵ Long-term studies of weight loss in individuals participating in the NWCR indicate that those who re-gain weight typically show a demonstrated decline in self-monitoring. This includes techniques such as frequent self-weighing as well as keeping food and exercise diaries. These individuals showed a marked decrease in physical activity of more than 800 calories per week, coupled with increases in the percentage of calories taken in from fat. The study also showed the re-gainers to have a higher lifetime level of intentional weight cycling.⁵ Those who regained weight were more likely to have sought assistance for weight loss rather than utilizing self-directed weight loss methods, and were more likely to have used a liquid formula diets for their initial weight loss. In comparison, it has been shown that 72% of successful weight losers lost weight on their own, 20% used commercial weight loss programs and 5% utilized a university-based program.⁶ Those who gained weight also were shown to have been heavier at their maximum weight, initially lost a greater percentage of their maximum weight (>30%) and had maintained their weight loss for fewer years than maintainers.⁵

What predicts successful weight maintenance? Research has shown the five most common links appear to be 1) Physical Activity 2) Self-Monitoring 3) Problem Solving 4) Continued Contact 5) Stress Management.⁷

Physical Activity: Longitudinal studies with 2-10 years of follow up results have observed that physical activity is related to less weight gain over time.² It is a well-known fact that physical activity is a good predictor of weight maintenance.⁷ A review of successful weight maintainers reveals that they engaged in more strenuous activities such as running, weight lifting and aerobics than weight regainers, and participated in more activities that made them sweat.⁸ Specifically, 52% of maintainers reported engaging in three or more episodes that made them sweat in a typical seven-day week compared to 32-36% of the regainers and controls.⁸ Although, it is important to note it has been demonstrated that both gainers and maintainers reported decreases in total calories expended thorough physical activity. However, maintainers reported a decrease of only 500 calories per week where gainers reported a decrease of almost 1000 calories per week at one-year follow up.⁵

Self-Monitoring: Self-monitoring is the cornerstone of behavioral treatment.⁷ One of the common findings observed in individuals who are successful at long term weight loss is that maintainers report extensive use of behavioral strategies for reduction in dietary fat intake, self weighing and physical activity.⁸ Taking a closer look at self weighing as a form of self-monitoring, it has been shown that 55% of maintainers reported weighing themselves at least once each week, where only 35% of the regainers reported weighing themselves frequently.⁸ Other forms of self-monitoring, such as keeping a food or exercise record, functions to assist the patient in assessing overall intake of various foods in relation to the amount of exercise performed. Despite the fact that caloric intake may be underestimated, the records sensitize patients to the eating and exercise portion of their lifestyle.⁹

Problem Solving: Generally, it has been shown that those individuals who confront life's stresses with a positive problem-solving attitude are more likely to have greater success in any endeavor.⁷ All aspects of effective obesity treatment involve improved problem solving and confrontational skills. A survey of weight maintainers showed that 95 percent of them utilized problem solving or confrontational technique. In comparison only 10% of those who relapsed used problem solving skills and instead, tended to use escape-avoidance ways of coping with stress, such as eating, smoking, or taking tranquilizers.⁹ These findings support the theory that once an individual makes a behavioral change, relapse occurs in the face of insufficient coping skills.⁹

Continued Contact: Frequent patient-provider contact is associated with the best maintenance of weight loss.¹⁰ This contact does not have to be given solely by the physician, but by a registered dietitian, nurse, office staff. Contact can be made to patients, via phone, fax or email. These continued visits have been shown to enhance motivation, troubleshooting and teach patients a new set of skills. Overall, the longer patients remain in behavioral treatment the longer they are expected to maintain their weight loss.¹⁰

Stress Management: Literature has shown that stress has a facilitating effect on the eating behavior of individuals most likely to be patients in a weight loss program.⁹ This excessive stress appears to predict early drop out from organized weight loss programs.⁷ It is essential to help patients identify a strategy when confronted with stressful events, to allow them to gain quick composure in order to use other behavioral techniques.⁹ Working with patients to help address and alleviate the stress-eating relationship in weight loss treatment and maintenance is of key importance.⁷ Four basic stress management procedures used in weight maintenance include self-monitoring, environmental control, relaxation training and contingent relaxation.⁹

Conclusion

Regardless of the weight loss option selected, patients should strive to develop the skills that have been reported by successful weight loss maintainers. These techniques include exercising regularly, monitoring weight frequently, eating a low fat diet, recording food intake, and developing effective problem solving skills.¹⁰ In addition, believing in yourself¹¹ and not relying on willpower can help your patients achieve success in their weight maintenance endeavors.

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15. FACTORS AFFECTING LONG-TERM MAINTENANCE OF WEIGHT LOSS AND WEIGHT REGAIN

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Obesity is a significant health problem in the United States, and it is estimated that in excess of 50 percent of adults are considered overweight ($BMI > 25 \text{ kg/m}^2$). Despite documented short-term success in weight loss programs, it has been shown that typically, one-third of weight lost will be regained within 1-3 years, with total regain occurring within 3-5 years. Therefore, it is important to examine the most effective implementation of strategies that have been shown to maximize long-term weight loss and prevent weight regain.

Despite the belief that most individuals are unsuccessful at long-term weight loss, the *National Weight Control Registry (NWCR)* has identified a large number of individuals that have successfully maintained at least a 30 pound weight loss for a minimum of one-year⁸. Close examination of this data set shows that there are individuals that have maintained a weight loss of approximately 60 pounds and have maintained this for 5.6 ± 6.8 years. Therefore, results from this study should be examined closely to determine if there are unique strategies that can be used to enhance long-term weight loss in overweight adults.

Exercise

An interesting finding in the NWCR is that individuals continue to participate in strategies to maintain both healthful eating and exercise behaviors. However, a unique finding in this data is that these individuals are maintaining extremely high levels of exercise, with leisure-time activity being 2000 to 2500 kcal/week for both men and women⁸. This value is much greater than the current public health recommendation for physical activity to improve health^{12,17}. However, this level is similar to the amount of activity shown by Schoeller et al.¹⁶ to minimize weight regain in overweight women, and this amount of activity was verified using doubly labeled water. Jakicic et al.⁷ have shown that when combined with dietary modification, weight regain in the 12 months following was minimized when exercise exceeded 150 minutes per week. However, of interest is that there was no weight regain in women exercising greater than 200 minutes per week throughout the entire 18 months of treatment. Thus, overall, these results appear to verify the conclusion of Pronk and Wing¹⁴ based on a review of the literature, that physical activity is one of the best predictors of long-term weight maintenance.

Despite the evidence presented above, debate remains regarding the optimal intensity of the activity that will enhance long-term weight loss and minimize weight regain. In a 20-week study of overweight women, Duncan et al.² showed that total energy expenditure rather than exercise intensity is the key factor for regulating body weight. However, data from the NWCR suggests that individuals success at long-term weight loss participate in a high level of vigorous intensity activity⁸. Despite these findings, the results of this study are cross-sectional and have not been confirmed by a randomized clinical trial. Currently, Jakicic and colleagues are conducting a randomized clinical trial to examine the dose-response of exercise (intensity and energy expenditure) on weight loss across a 24 month period of time.

Despite the debate over the optimal amount of activity that is necessary to maximize long-term weight loss, little debate exists as to the importance of physical activity for overweight adults. Data from the Center for Aerobics Research at the Cooper Institute have shown that physical fitness can have a significant impact on mortality rates independent of body weight. Lee et al.⁹ have shown that there is a significant reduction in mortality rates in overweight adults that also have higher levels of physical fitness, and this mortality rate is similar to leaner unfit adults. These results suggest that interventions that improve physical fitness in overweight adults can have significant health benefits independent of changes in body weight. Therefore, it is important to develop and implement strategies to increase exercise participation in overweight adults.

Recently, Dunn et al.³ have shown that a home-based lifestyle activity intervention can be as effective over 18-24 months as a structured clinic-based exercise intervention. In addition, in studies of overweight women, Jakicic et al.^{6,7} have shown that multiple short-bouts of exercise can be an effective the adoption of physically activity in previously sedentary individuals. Therefore these strategies should be considered when implementing interventions to address body weight regulation within the military.

Changes in the Micro and Macro Environments

It has been suggested that we live in a “toxic environment” relative to factors that affect body weight. There are a number of factors such as accessibility of high fat/calorie foods and labor saving devices that affect our eating and

exercise behaviors. However, it has been shown that the environment can be manipulated to have a positive impact on eating and exercise behaviors. For example, French et al.⁴ showed that lowering prices in vending machines for low-fat snacks increased the amount of low-fat snacks that were purchased. In addition, Andersen et al.¹ have reported that posting signs to encourage the use of stairs in a shopping mall can have a positive impact on activity patterns.

It may also be important to increase access to healthier foods and provide opportunities for physical activity, and this can be done to both the macro and micro environments. For example, Sallis et al.¹⁵ showed that individuals living in close proximity to exercise facilities were more active than those living further away from these facilities. Jakicic et al.⁵ showed that there was a significant correlation between physical activity and having home-exercise equipment. More recently, Jakicic et al.⁷ reported that providing overweight adults with home treadmills increased exercise participation. Therefore, these findings suggests that modifications to the environment may have a positive impact on health behaviors related to body weight regulation.

Long-term Changes in Dietary Intake

Despite the fact that exercise appears to be one of the best predictors of long-term weight loss, the impact of eating behaviors on this process should not be overlooked. It has been shown in short-term studies that exercise alone has little impact on body weight when compared to diet or the combination of diet plus exercise¹⁸. Moreover, the effectiveness of exercise in long-term weight loss may be partially explained by its link to healthful eating behaviors. For example, Klem et al.⁸ reported that individuals successful at long-term weight loss maintained healthful eating behaviors along with high levels of exercise. Unpublished data from a study conducted in our laboratory has shown that individuals that have maintained high levels of exercise also report maintaining more healthful eating behaviors than those not maintaining their exercise over a period of 18 months. Thus, these results appear to suggest that both dietary and exercise behaviors should be targeted to enhance long-term weight loss and to prevent weight regain.

Continued Contact

It has been suggested that obesity is a chronic disease and should be treated with a chronic disease intervention. Perri et al.¹³ have shown that maintaining contact with a weight loss program long-term enhances weight loss. However, from a clinical perspective, it becomes difficult to keep individuals in treatment programs for long periods of time. Thus, the typical model of providing group sessions during the maintenance phase of treatment may not be appealing to individuals participating in these programs. Therefore, maintaining contact through other means may prove to be more effective in long-term intervention programs. Some of the strategies that have been shown to be successful are telephone contacts and mailings. In addition, interventions using social support strategies and computers are currently ongoing. Therefore, these intervention strategies may be appealing to the military when attempting to deliver interventions to soldiers that may be deployed throughout the world.

Targeting High Risk Periods for Weight Gain – What Can Be Done?

There is some evidence that there are specific periods when individuals may be at risk for weight gain, and this may be an important factor for the military to consider. One period of time is during early adulthood, and weight gain is typically accompanied by a trend for there to be a decrease in physical activity. For example, unpublished data from our laboratory has shown that college-aged men and women participating in regular exercise gained less weight during their college years than those not regularly participating in exercise.

Weight gain may also occur in individuals that are already moderately overweight. We have shown that moderately overweight adult men left untreated will gain a significant amount of weight over a period of 16 weeks, whereas participation in a program to modify exercise behaviors and minimize fat intake appears to have a beneficial effect on body weight in these individuals¹¹. Therefore, it may be important for the military to identify individuals that are moderately overweight and encourage changes in exercise and eating behaviors to prevent further weight gain.

The postpartum period may be an extremely important time for women with regard to body weight regulation, and interventions targeting this period may be extremely important. For example, in a study of women following pregnancy, women left untreated lost 4.9 kg with 11.5% returning to pre-pregnancy weight, whereas those participating in a correspondence-based treatment program lost 7.8 kg and 33% returned to pre-pregnancy weight¹⁰. Therefore, it may be important for the military to consider offering postpartum interventions to minimize the retention of body weight in women during this period.

Application to Weight Regulation Initiatives and Regulations in the Military

There may be some debate in the various branches of the military regarding acceptable body weight values and methods of measuring these parameters. However, regardless of the absolute value that is determined to be acceptable, it should be recognized that there are soldiers in the military that are at risk for weight gain. Therefore, the military should consider implementing strategies that may minimize weight gain in these individuals, and these could include changes in the environment and providing access to programs related to eating and exercise behaviors.

In addition, the military should consider implementing interventions early on (i.e., basic training) that will permit soldiers to transfer their activity and eating behavior outside of a controlled environment setting. For example, when an individual enters the military, it is commonly believed that they are in an environment in which they have little control over their eating and exercise behaviors, and these factors are controlled by the military. However, soon after that period of time, soldiers have more freedom of choice, and this is a period when they could potentially relapse into typical behavioral patterns. Thus, providing opportunities for soldiers to maintain their newly developed exercise and eating behaviors may minimize body weight regulation concerns in this population. Moreover, one factor that should be considered is the history of the soldier prior to entering the military. It is likely in some cases that an individual lost weight just prior to entering the military in order to conform to the military standards and to be accepted into the military. However, the period following this initial weight loss is a high risk time for weight regain. Identifying individuals that meet these criteria, and targeting interventions at this group of individuals may prove to be beneficial in preventing relapse while in the military.

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